Knowledge building in configuring metropolitan water governance

Water-related climate risk scenarios, governance networks, concertacion processes and territorialities in Lima, Peru

Miranda Sara, L.R.

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LILIANA MIRANDA SARA

UNIVERSITY OF AMSTERDAM

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Here we are, I learned to live with my new academic and scientific "hat" that I accept, enjoy, and wear. How right my advisers were about the importance of theory and concepts, and I think I have managed to contribute to it here. Enjoy this thesis as I did (most of the time) while writing it, and finally, thanks also to you for reading my work. I strongly recommend it to you, I think you will realize it is worth the time.

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Acronyms List

AFIN: Association for the Development of National Infrastructure (Asociacion para el Fomento de la Infraestructura Nacional)
ALAs: Local Water Authorities (Autoridades Locales del Agua)
ANA: National Water Authority (Autoridad Nacional del Agua)
BIRF: International Bank for Reconstruction and Development (Banco Internacional de Reconstrucción y Fomento)
CBO: Community-Based Organisations
CC: Climate Change
CENEPRED: National Estimate, Prevention and Reduction of Disaster Risk Centre of Peru (Centro Nacional de Estimacion, Prevencion y Reduccion del Riesgo de Desastres)
Chance2Sustain, C2S: 'Urban Chances, City Growth and the Sustainability Challenge' research project
CIB: Cross-Impact Bilanzanalyse
COFIDE: Development Finance Corporation from Peru (Corporación Financiera de Desarrollo S.A.)
COP20: 20th Conference of the Parties, Lima Climate Change Conference
CSO: Civil Society Organisation
DIGESA: General Directorate of Environmental Health of Peru (Dirección General de Salud Ambiental)
DRR: Disaster Risk Reduction
EDEGEL: Electricity Generation Company (Empresa de Generacion Electrica)
ENSO: El Niño System Oscillation
EPS: Sanitation Service Provider Enterprises (Entidades Prestadoras de Servicios de Saneamiento)
EU: European Union
FONAFE: National Fund to finance the entrepreneurial activity of the State of Peru (Fondo Nacional de Financiamiento de la Actividad Empresarial del Estado)
FORO: Cities for Life Forum
FOVIDA: Fomento de la Vida foundation
GDP: Gross Domestic Product
GHG: Greenhouse Gases
GIS: Geographical Information Systems
GIZ: German Federal Enterprise for International Cooperation
GRC: Regional Government of Callao (Gobierno Regional del Callao)
INGEMMET: Geological, Mining and Metallurgic Institute of Peru (Instituto Geológico, Minero y Metalúrgico)
IADB: Inter-American Development Bank
IFAK: German Institute for Automation and Comunication
ILPE: Institute of Landscape Planning and Ecology
IMP: Metropolitan Planning Institute (Instituto Metropolitano de Planificacion)
INADE: National Institute of Development of Peru (Instituto Nacional de Desarrollo)
INDECI: Civil Defence National Institute (Instituto Nacional de Defensa Civil)
INEI: Institute of National Statistics and Information of Peru (Instituto Nacional de Estadistica e Informatica)
IPCC: International Panel on Climate Change
IWRM: Integrated Water Resource Management
JAAS: Water and Sanitation Management Boards (Juntas Administradoras de Agua y Saneamiento)

JICA: Japan International Cooperation Agency
KFW: German Development Bank
LEIS: Lima Ecological Infrastructure Strategy
LiWA: Sustainable Water and Wastewater Management in Urban Growth Centres Coping with Climate Change - Concepts for Lima Metropolitana Research Project
MML: Metropolitan Municipality of Lima (Municipalidad Metropolitana de Lima)
MPC: Provincial Municipality of Callao (Municipalidad Provincial del Callao)
NGO: Non-Governamental Organisation
OEFA: Office of Evaluation and Audit of the Environment of Peru (Organismo de Evaluación y Fiscalización Ambiental)
PPP: Public Private Partnership
SEDAPAL: Lima's drinking water and sewerage company (Servicio de Agua Potable y Alcantarillado de Lima)
SENAMHI: National Meteorology and Hydrology Service of Peru (Servicio Nacional de Meteorologia e Hidrologia del Peru)
SUNASS: National Agency of Water and Sanitation Services (Superintendencia Nacional de Servicios de Saneamiento)
SUTESAL: SEDAPAL's Workers Union (Sindicato Único de Trabajadores de Sedapal)
UCCRN: Urban Climate Change Research Network
UNDP: United Nations Development Program
UNI: National University of Engineers of Peru (Universidad Nacional de Ingenieros)
UNISDR: United Nations International Strategy for Disaster Reduction
USD: United States Dollar
WB: World Bank
WHO: World Health Organisation
ZIRIUS: Stuttgart Research Centre for Interdisciplinary Risk and Innovation Studies

Summary

Peru is one of the ten countries most vulnerable to climate change, with the recurrent effects of El Niño (ENSO) exacerbating that vulnerability. Metropolitan Lima, Peru's capital city on the Pacific Coast with almost ten million inhabitants, suffers both high levels of climate-related water stress and flooding hazards, and unequal distribution and tariffication of water. This makes Lima a relevant case to examine how water governance is configured in climate trends and future risks attributed to climate change.

This thesis draws on three debates. First, it draws on a new concept of sustainability, approaching development dimensions with a holistic vision where nature (particularly water) is recognised as another actor exercising its power. This changes the ways of exercising governance and management, fostering a new perspective on sustainability. Including nature in the analysis helps shape a complete understanding of vulnerability to reduce the risk of disasters.

The second debate concerns the understanding of governance networks as configurations, where discourses and actors' coalitions and networks in inclusionary and iterative knowledge constructions within *concertacion* processes are visible, displaying the power dynamics and territorialities in practice; state and governance configurations are seen as heterogeneous structures, built up of actor networks working within institutions while also changing them.

The third debate addresses water-related risks, especially those attributed to climate change. There are four strands in the literature on water-related risks, disasters and climate change: the social construction of disaster, disaster risk reduction, climate change scenario-planning and lastly anticipation studies.

This thesis contributes to these debates, both empirically and theoretically, because it has identified and analysed the interconnection of the different discourses and main arguments on sustainability, water systems, cities and risks attributed to climate change, particularly those influencing Lima´s water governance configuration.

This led the author to develop the main research question: How are Lima´s water governance networks being reconfigured in terms of discourses, network coalitions, territorialities of practice and inclusionary knowledge building processes to face water-related risks, vulnerabilities and inequalities associated with climate change?

The main research question was structured into the following four specific research questions:

1. How are Lima's water governance networks configured, in terms of main actors, discourses and practices, power relations, policy knowledge flows, territorialities and outcomes?
2. How do mapping processes, built up through iterative knowledge construction in *concertación*[1] processes in Lima, reveal uneven geographies of water-related (climate change) risks, vulnerabilities and inequalities in cities (and territories)?
3. To what extent do *concertación* processes exchange knowledge, build trust and enable joint planning? (and how does the (ex)inclusion of different types of knowledge contribute to them?)

[1] '*Concertación*' has no direct translation into English. It refers to the process of building up socially supported agreements, decisions for taking coherent joint action through dialogue and deliberation. In this thesis I use the words 'concertación' and '*concertacion*' interchangeably.

4. How do knowledge construction and risk perceptions of water-related disaster risks and vulnerabilities affect decision-making and implementation in urban governance networks?

This research employed a participatory and *concertación* problem-solving action-based research with the involvement of multiple real actors (and their networks and coalitions) in metropolitan Lima (shortened to 'Lima' for the remainder of the text). The research is based on my experience as an activist leader of the Cities for Life Foro[2] which plays a strong advocacy role in many such processes. As such, the research has generated academic products as well as contributed to policy.

To make my starting point transparent, I here clarify my stances as a researcher in terms of discourses on water, cities and sustainability, as well as my main approach to governance processes. In terms of discourses, I see water as a socio-ecological good (Miranda Sara et al., 2014). I view cities as a node of crucial territorial practices, utilise the concept of new sustainability, and study *concertación* processes as a Peruvian form of democratic processes and participation.

This research started in 2010 and, for this dissertation, ended in 2019 (with a break between 2016/2017). During that period, many real actors from diverse institutional levels, sectors, disciplines and geographical scales were invited to participate in my research in different ways, a process in which I helped develop their capacities to build anticipatory short and long-term scenarios (and visions). I also used dialogues and debates with the public on social media, such as Facebook and Twitter, as part of a wider process of the social construction of knowledge.

The main methodologies to answer the four research questions were interviews with strategic actors and community members and a problem-solving, learning-by-doing action-based research in advocacy processes. In the latter, I analysed how their discourses influence and interconnect within an actor network governance configuration and draw on a territorial analysis to follow the flows of water within the hydrological cycle and territorialities in practice. This approach helped in understanding the level of inequalities, vulnerabilities and risk normalisation and tolerance with metropolitan cities such as Lima.

I started from the premise that actors (public, private, politics, community and academic, among others) and actor networks use their knowledge and knowledge power to influence water governance policy developments and outcomes in their cities and territories, exercising (or not) democratic governance and participatory management under inclusionary (*concerted)* and transparent processes. If not considered or being misinformed or used, they may contest and even develop a confrontation process aiming to be heard. This is not a linear process, but dynamic, depending on knowledge and power imbalances, relations and dynamics.

Different kinds of knowledge are involved, such as i) tacit, ii) expert, iii) contextual and iv) scientific knowledge (Pfeffer, 2018), without excluding, hiding, negating or refuting any of them. Techniques for promoting a process of social construction of knowledge were applied during the action research with practitioners and efforts were made to make it more widely available beyond the context where it had been generated.

[2] www.ciudad.org.pe (accessed 02 March 2017)

Methodologically, the thesis used 1) water governance configurations as the analytical lens; 2) scenario-building, planning and sharing (developing anticipation capacities); and 3) territorial analysis using qualitative and quantitative data and analytical tools.

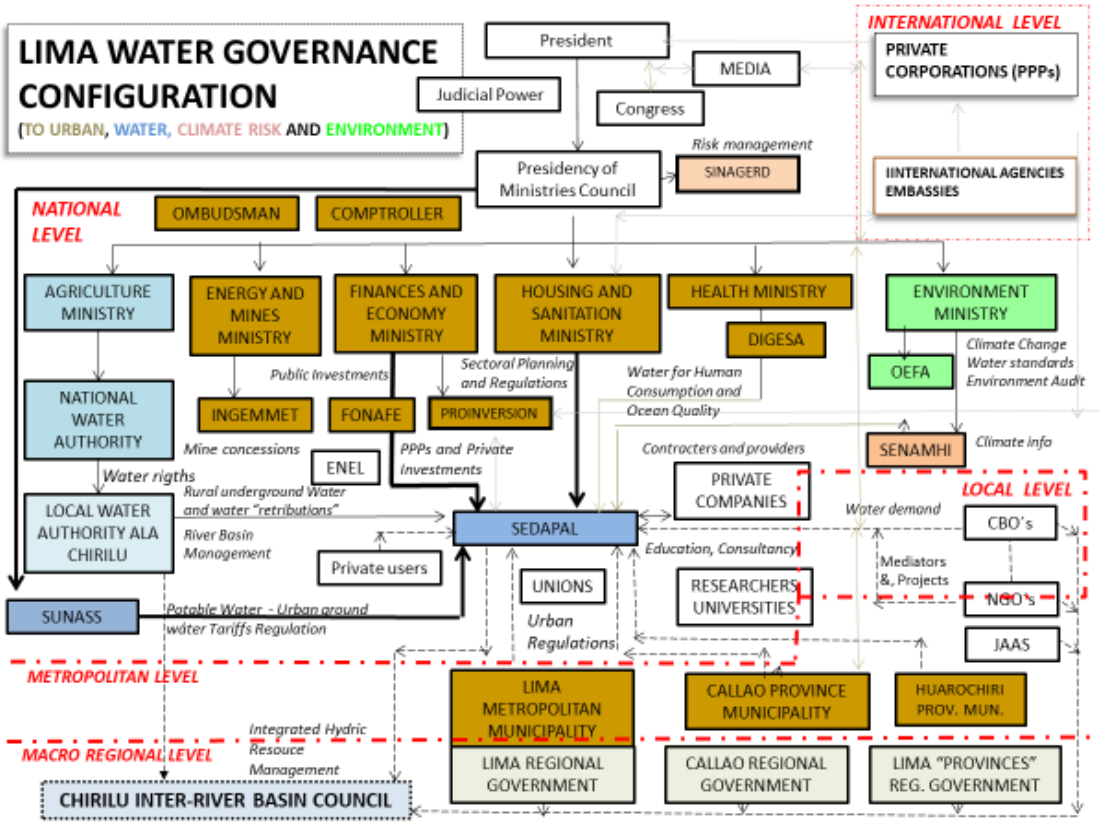
Regarding the first research question, Chapter Four analyses how complex water governance networks and their dynamics in Lima are configured, and their implications for urban water provision, particularly conflicts, socially supported agreements and uneven outcomes. We examined how discourses, policy knowledge flows, power relations and mandates across territorialities (re)configured water networks. We shifted from the predominant water governance discourse as being unique or monolithic to an interactive water governance actor network configuration processes implying dynamic interactions between multiple actors. In doing so, Chapter Four identified, analysed and validated four discourses and four actor networks with different levels of power to influence policy development (networks which move between conflict, negotiation and *concertación*).

Using the concept of water governance configuration allowed us to examine how the water governance system is assembled via a powerful dominant network with a modernisation and privatisation discourse focused on urban drinking water provision. This approach brought to the fore the importance of power relations in shaping discursive practices, as overlapping institutions, fragmentation of territorial mandates, regulatory powers, weak representation and participation practices, difficult accessibility and weak transparency of policy knowledge flows prevented other networks from building up a more integrated system. This dominant network maintains its discourse in the face of alternative conceptualisations emerging in the regulatory control network and those people aiming to equalise provision between water users, and increase governance capacities for climate change adaptation to reduce risks and CC impacts at multiple territorial scales.

Analyzing the water governance network as configuration also allowed us to recognise multi-scalar territorialities in one framework and to examine spaces and actors dealing with complex issues of water overexploitation, inequalities and vulnerability. Links were found between groups dealing with social and environmental problems and conflicts, new generations of water alliances could be built up within multiple territorialities to counter-balance existing power relations and reduce inequalities and risks.

The main result from this analysis shows the networks of multiple institutions, ranging from international agencies, private corporations, macro-regional level organisations and national organisations, to local governments and civil society actors. In contrast to many cities elsewhere, Lima local governments have little to say on water provision. The main conclusion is that one dominant network sets discourses, rules and does implementation, although power relations are being renegotiated. Emerging networks strengthening judicial and control mechanisms are slowly including wider communities, but their power remains limited. The network configuration faces the paradox that current water demands of all users combined may no longer be feasible within ecological limits and future climate change consequences.

Figure S.1 Actor Network Lima Governance Configuration



Note: the colour of the boxes is sectoral: urban (brown), water (blue), risk (pink) and environment (green).

Source: Author, November 2017 updated version based on Miranda, Baud and Pfeffer (2016)

For the second research question, Chapter Five analysed how different discourses influence knowledge-building processes in terms of main concerns, water sector boundaries, water tariffs and types of information that are considered legitimate in Lima. We analysed how iterative mapping processes within three *concertación* and action research processes[3] in Lima reveal uneven geographies of water-related vulnerabilities and inequalities, presenting the outcomes of the cross-boundary processes of social construction for generating, analysing and exchanging knowledge. We showed how these processes are embedded in the urban configuration and how the legitimacy of mapping processes needs to be negotiated across boundaries.

Inequality became much more visible when observing how costs differ between users (urban, rural and sectoral). A Lima city dweller unconnected to water services may pay USD 3.74 USD per m^3, while someone who is connected pays around 0.83 USD per m^3 to SEDAPAL. At the same time, private sector users, such as mines and industries, can pay only 0.08 USD per m3 while using huge volumes of crystal clear water and generating high revenues (to the

[3] The first project was led by a German-financed research program LiWA, which developed climate change scenarios and water simulation models. The second was the Municipality of Lima committee for climate change adaptation strategies and the third the Chance2Sustain (C2S) research project, which opened up a discussion on more spatial perspectives in city development and water governance. These three projects were running almost parallel in time.

Agriculture Ministry, via the National Water Authority, ANA), which can put the city at higher risk of drought, and generating high levels of conflict (Miranda Sara et al., 2016). Our question, still open to discussion, is why these inequalities remain.

Economic efficiency takes precedence in these decisions, but unfortunately, Sunass does not evaluate SEDAPAL for its eco-efficiency, its equality nor its long-term hydrological sustainability but rather for its short-term economic profits. Still, SEDAPAL provides basic levels of water to at least two million inhabitants in Lima against a subsidised tariff and, according to what they say, at a higher provision cost. It provides higher levels of water to residential users who pay more (and commercial and industrial users) and leaves more than a million people without domestic connections without water; they instead depend on cistern trucks (a very expensive and low-quality water). With current distribution and consumption patterns, there is not enough water for everyone; even if SEDAPAL were providing equally 80ltrs/person/day (recommended amount according to World Health Organization) to each inhabitant, its drinking water production would not be sufficient (Miranda Sara et al., 2016).

A conclusion from our second specific research question is that action-research and policy-building processes can reflect how mappings of 'water-related risks and vulnerabilities' are socially constructed. First, maps draw on different discourses and framings, data inputs and classifications at multiple territorial scales. Second, they visualise inequalities linking multiple dimensions, building a more integrated understanding of the dynamics and territorial differentiation of Lima's 'waterscape', combining human and natural processes. This, in turn, contributes to legitimising the discussion of different types of knowledge among actors. Third, maps facilitate 'exchange on priorities, conflicts and synergies', providing inputs into negotiation processes between actors in water governance configurations. That said, it is necessary to ensure the incorporation of such mapping processes into policymaking and implementation for wider acceptance.

My third research question was to what extent *concertación* processes exchange knowledge, build trust and facilitate joint planning (and how the (ex)inclusion of different types of knowledge contribute to them). In Chapter Six, the same three processes were analysed in terms of the consequences of plausible Lima climate change scenarios. Outlining the water-related risks attributed to climate change, we examined what contributions processes of socially constructing knowledge could make to climate change adaptation strategies. The focus was on the extent to which *concertación* processes included a wider range of actors, discourses and knowledge in metropolitan governance and how these influence shifts in decision-making priorities.

Although these project processes used *concertación* and social knowledge construction, the actors and kinds of knowledge incorporated differed. Whereas LiWA remained dominated by professional groups and technical knowledge, the Lima committee on climate change strategy and Chance2Sustain processes included a wider range of actors and community knowledge and practice, moving towards transitions in thinking about adaptive management and knowledge building.

No one actor ever has all the power over a city´s development. This holds true particularly in a metropolitan city such as Lima where knowledge is dispersed and fragmented among many actors, who lack a comprehensive overview about the present situation and even less about the whole city´s future. Actors do not necessarily have to know everything about every sector or the whole city, so the focus in this research was how knowledge is constructed, shared and

used, as well as how knowledge travels and helps (or not) to build up mutual understandings among many actors, so they can not only communicate, coordinate, but '*concertate'*.

A key conclusion from the third research question was that actors can build up agreements, even having different discourses, bringing in knowledge from different territorial scales and institutional levels and initiating collaborative actions over time, providing inputs for scenario building on cities towards future forms of water and climate change adaptations. However, such processes may include strong discussions, conflicts and the recognition of other's discourses, and they may require the inclusion of many knowledges (expert, codified, tacit and contextual) in order to build up scenarios capable of 'visualising' and anticipating what might happen when conditions change in the future. Those processes require democratic, transparent and decentralised institutions, providing strong mandates and political to support them, so the views of the poor, vulnerable are included and can make themselves heard.

In Chapter Seven, we analysed our fourth specific research question on how knowledge construction and risk perception on water-related disaster risks and vulnerabilities affects decision-making and implementation in urban governance networks, specifically looking at some reasons behind high levels of risk tolerance and lack of initiatives in putting adaptation and/or preventive measures in place.

Two case studies were analysed, which either already are or can become disasters. The first concerns an analysis of the long-term territorial mapping scenarios of water scarcity and droughts by 2040, combining population growth rates and water distribution and consumption through Chance2Sustain. The second refers to short-term extreme climate events recurrently manifesting as mudslides and floods associated (or not) with El Niño in eastern Lima, in Chosica. The analysis was conducted at the metropolitan city scale as well as at a vulnerable community scale, illustrating an iterative territorial knowledge construction process, where risk prioritisation, normalisation and tolerance occur, with a resulting [in-]action by actors. Knowledge about hazards and potential actions for risk reductions did not travel until a disaster happened in 2017.

The methodology used collective and iterative mapping processes, using technical, organisational and geographical knowledge from a variety of governance experts and practitioner networks in Lima. The main outcome was the social learning derived from bringing together different kinds of knowledge and integrating several dimensions through spatial representations. This has raised awareness, increased capacities for dealing with uncertainty and contributed to the approved metropolitan climate change adaptation strategy, which was not prioritised by the Lima municipality until a newly elected mayor took over in 2019.

Two conclusions were drawn regarding the fourth research question. One, spatial planning is a political process, in which knowledge is contested or even when acknowledged, does not necessarily steer decision-making processes, either by local communities, authorities and private institutions. Two existing models linking knowledge construction to risk framing, risk tolerance and how these influence decision-making processes and actions to prevent disaster may ignore risk tolerance, through normalisation and prioritisation, at their peril.

Coming back to the main research question, the main conclusion was that knowledge is more easily displaced in hybrid multi-actor and multi-institutional (and trans-disciplinary) networks

when the mandates and political policies (*concertative*[4]) are supported with transparent information as a pre-requisite. Such processes need to be iterative and interactive cycles in constant evolution of dynamic.

Using the water governance configuration as a main conceptual framework made it possible to recognise multi-scalar territorialities and water trajectories and show the lack of connections between the city, the macro-region and wider ecosystem levels.

This conceptual framework on urban water governance was linked to debates on knowledge building, which provide insights into four main areas. The first insight addresses the inequalities experienced in what knowledge is accepted and considered legitimate. The second concerns how spatialising or mapping knowledge can contribute to making more visible inequalities, fragmentation and concentrations in 'territorialities' in practices. The third insight concerns the ways that risk perceptions are linked to adaptive management and how different knowledges are embedded in such processes. Where they normalise risks, the possibility of disaster increases. The fourth insight is that linking the issues of knowledge building to metropolitan water governance configuration contributes to a better understanding of the complexities faced by the actors in climate change and the uncertainties faced by those who want to tackle such issues.

Finally, the recommendation for future research and the policy links which came out are framed as questions:

- How can we build inclusive and interactive multi-actor, multi-scalar, multi-level and multi-temporal water governance structures for climate-proof metropolitan cities' new configurations?
- How can we lead and articulate risk reduction, adaptation and anticipation processes for uncertain and unknown futures?
- How can we coordinate participation and inter-institutional spaces (between civil defence, river basin management and urban-rural-natural land use) with climate change scenarios?
- How can we develop the political will to guarantee long-term equal water provision?

[4] A variety of actors take part, even in processes with an obligatory character, in which one learns by doing, constructs a collective knowledge through diverse discussions, spaces of dialogue and through social networks.

Resumen

Perú es uno de los diez países más vulnerables al cambio climático, y los efectos recurrentes de El Niño (ENSO) agravan esa vulnerabilidad. La ciudad metropolitana de Lima, capital del Perú en la costa del Pacífico, con más de diez millones de habitantes, sufre tanto altos niveles de estrés hídrico relacionado con el clima como de riesgos de inundaciones, así como una distribución y tarificación desigual del agua. Esto hace que Lima sea un caso pertinente para examinar cómo se configura la gobernanza del agua relacionado a los escenarios climáticos y los riesgos atribuidos al cambio climático en el futuro.

Esta tesis se basa en tres debates. En primer lugar, se basa en un nuevo concepto de sostenibilidad, que aborda las dimensiones del desarrollo con una visión holística en la que se reconoce a la naturaleza (en particular al agua) como otro actor que ejerce su propio poder. Esto cambia las formas de ejercer la gobernanza y la gestión, fomentando una nueva perspectiva de la sostenibilidad. Incluir la naturaleza en el análisis contribuye a una comprensión más completa de la vulnerabilidad para reducir el riesgo de desastres.

El segundo debate se refiere a entender las redes de gobernanza como configuraciones, en las que son visibles los discursos, las coaliciones y redes de actores en procesos de construcción del conocimiento inclusivos e iterativos en el marco de procesos de concertación[5], que muestran las dinámicas del poder y las territorialidades en la práctica; generalmente, las configuraciones del Estado y la gobernanza se consideran estructuras heterogéneas, dinámicas, constituidas por redes de actores que trabajan con y dentro de las instituciones, a la vez que las modifican.

El tercer debate se refiere a los riesgos relacionados con el agua, especialmente los que se atribuyen al cambio climático. En la literatura sobre los riesgos relacionados con el agua, los desastres y el cambio climático hay cuatro vertientes: la construcción social del desastre, la reducción de riesgos de desastre, la planificación de escenarios de cambio climático y, por último, los estudios de anticipación.

Esta tesis contribuye a estos debates, tanto empírica como teóricamente, porque se ha identificado y analizado la interconexión de los diferentes disertaciones y argumentos principales sobre la sostenibilidad, los sistemas hídricos, las ciudades y riesgos atribuidos al cambio climático, en particular los que influyen en la configuración de la gobernanza del agua en Lima.

Esto me llevó a desarrollar la principal pregunta de investigación: ¿Cómo se están reconfigurando las redes de gobernanza del agua de Lima en términos de discursos, coaliciones de redes de actores, territorialidades en la práctica y procesos de construcción del conocimiento inclusivos para enfrentar los riesgos, vulnerabilidades y desigualdades relacionadas con el agua asociados al cambio climático?

Esta principal pregunta de investigación se estructuró en las siguientes cuatro preguntas de investigación específicas:

1. ¿Cómo se configuran las redes de gobernanza del agua de Lima, en términos de actores principales, discursos y prácticas, relaciones de poder, flujos de conocimiento de políticas, territorialidades y resultados?

[5] 'Concertación' no tiene traducción directa al inglés. Se refiere al proceso de construcción de acuerdos con apoyo social, decisiones para tomar acciones conjuntas coherentes a través del diálogo y la deliberación.

2. ¿Cómo los procesos de cartografía construidos a través de la construcción iterativa de conocimiento en los procesos de *concertación* en Lima revelan geografías desiguales de riesgos, vulnerabilidades y desigualdades relacionadas con el agua (cambio climático) en las ciudades (y territorios)?

3. ¿En qué medida los procesos de concertación intercambian conocimientos, crean confianza y permiten la planificación conjunta? (y cómo contribuye a ellos la (ex)inclusión de diferentes tipos de conocimiento).

4. ¿De qué manera la construcción del conocimiento y las percepciones de los riesgos de desastre y las vulnerabilidades relacionadas con el agua afectan la toma de decisiones y la implementación en las redes de gobernanza urbana?

Esta investigación empleó una metodología participativa y de *concertación* basada en la investigación-acción con la participación de múltiples actores reales (y sus redes y coaliciones) en Lima metropolitana (abreviada como "Lima" para el resto del texto). La investigación se basa en mi experiencia como líder activista del Foro[6] Ciudades por la Vida ("Cities for Life"), que desempeña un importante papel de promoción en muchos de esos procesos. Como tal, la investigación ha generado productos académicos y ha contribuido en el diseño de políticas.

Para que mi punto de partida sea transparente, aclaro aquí mis posturas como investigadora en cuanto a los debates sobre el agua, las ciudades y la sostenibilidad, así como mi enfoque principal de los procesos de gobernanza. En términos de debates, veo el agua como un bien socio-ecológico (Miranda Sara et al. 2014). Veo las ciudades como un nodo de prácticas territoriales cruciales, utilizo el concepto de nueva sostenibilidad y estudio los procesos de *concertación* como una forma peruana de procesos democráticos y de participación.

Esta investigación comenzó en 2010 y, para esta disertación, terminó en 2019 (con una pausa entre 2016/2017). Durante ese período, se invitó a una serie de actores reales de diversos niveles institucionales, sectores, disciplinas y escalas geográficas a participar en mi investigación de diferentes maneras, proceso en el que ayudé a desarrollar sus capacidades para construir escenarios (y visiones) anticipatorios a corto y largo plazo. También utilicé los diálogos y debates con el público en los medios de comunicación social, como Facebook y Twitter, como parte de un proceso más amplio de construcción social del conocimiento.

Las principales metodologías para responder a las cuatro preguntas de la investigación fueron las entrevistas con actores estratégicos y miembros de la comunidad, una investigación-acción orientada a la solución de problemas y el aprendizaje práctico en los procesos de sensibilización. En esta última, analicé cómo sus discursos influyen e interconectan dentro de una configuración de gobernanza de redes de actores y me basé en un análisis de los flujos de agua dentro del ciclo hidrológico y las territorialidades en la práctica. Este enfoque ayudó a comprender el nivel de inequidades, vulnerabilidades y la normalización y tolerancia de los riesgos en ciudades metropolitanas como Lima.

[6] www.ciudad.org.pe (consultado el 2 de marzo de 2017)

Partí de la premisa de que los actores (públicos, privados, políticos, comunitarios y académicos, entre otros) y las redes de actores utilizan sus conocimientos, y el poder de su conocimiento, para influir en el desarrollo de políticas en el marco de la gobernanza del agua y en los resultados en sus ciudades y territorios, ejerciendo (o no) una gobernanza democrática y gestión participativa en el marco de procesos inclusivos (*concertados)* y transparentes. Si no son considerados o están mal informados o son utilizados, pueden impugnar e incluso desarrollar un proceso de confrontación con el objetivo de ser escuchados. Estos no son procesos lineales, sino dinámico, que dependen de los (des)equilibrios de conocimiento y de poder, de las relaciones y la dinámica generada.

Son diferentes tipos de conocimiento los que se involucraron, tales como I) tácito, II) experto, III) contextual y IV) científico (Pfeffer, 2018), sin excluir, ocultar, negar o refutar ninguno de ellos. Durante la investigación con los profesionales se aplicaron técnicas para promover un proceso de construcción social del conocimiento y se procuró que estas fueran ampliamente accesibles más allá del contexto en el que se habían generado.

Metodológicamente, la tesis utilizó 1) las configuraciones de la gobernanza del agua como lente analítico; 2) la construcción de escenarios, la planificación y el intercambio (desarrollo de capacidades de anticipación); y 3) el análisis territorial utilizando datos cualitativos y cuantitativos e instrumentos analíticos.

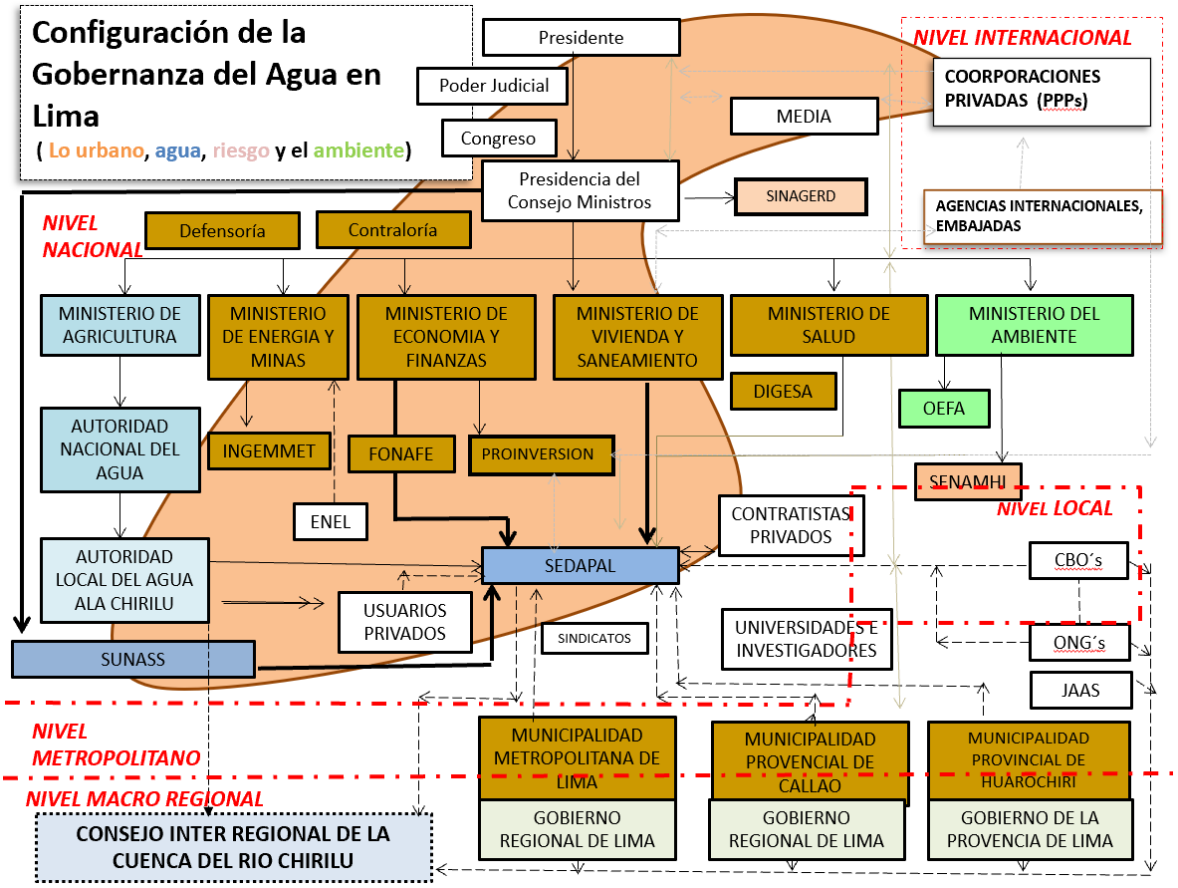
En cuanto a la primera pregunta de investigación, en el capítulo cuatro se analizó cómo se configuran las complejas redes de gobernanza del agua y su dinámica en Lima, y sus implicancias en el suministro de agua en zonas urbanas, en particular los conflictos, los acuerdos socialmente apoyados y los resultados desiguales. Examinamos cómo los discursos, los flujos de conocimiento en la generación de las políticas, las relaciones de poder y los mandatos a través de las territorialidades, (re)configuraron las redes de actores del agua. Pasando del discurso predominante sobre la gobernanza del agua como algo único o monolítico a procesos de configuración de redes interactivas de actores de la gobernanza del agua que implican interacciones dinámicas entre múltiples actores y redes de actores. De este modo, en el capítulo cuatro se identificaron, analizaron y validaron cuatro debates y cuatro redes de actores con diferentes niveles de poder que influyen en el desarrollo de las políticas (redes que se mueven entre el conflicto, la negociación y la *concertación*).

El uso del concepto de configuración de la gobernanza del agua nos permitió examinar cómo el sistema de gobernanza del agua está ensamblado a través de una poderosa red dominante con un argumento de modernización y privatización centrado en el suministro de agua potable en las ciudades. Este enfoque puso de relieve la importancia de las relaciones de poder en la configuración de las prácticas discursivas, ya que la superposición de instituciones, la fragmentación de los mandatos territoriales, los poderes de regulación, las prácticas de representación y participación débiles, la difícil accesibilidad y la escasa transparencia de los flujos de conocimiento en la generación de las políticas impidieron que otras redes construyeran un sistema más integrado. Esta red dominante mantiene su planteamiento frente a conceptualizaciones alternativas que están surgiendo como la red de control-regulación, aquellos intentando igualar el suministro entre los usuarios del agua y los que buscan aumentar las capacidades de gobernanza para la adaptación al cambio climático con el fin de reducir los riesgos e impactos a múltiples escalas territoriales.

El análisis de la red de gobernanza del agua como configuración también nos permitió reconocer territorios desde múltiples escalas geográficas dentro de un marco integrador y examinar los espacios y actores que se ocupan de cuestiones complejas como la

sobreexplotación del agua, las desigualdades y la vulnerabilidad. Se encontraron vínculos entre grupos que se ocupan de problemas y conflictos sociales y ambientales, y se pudieron construir nuevas generaciones de alianzas en torno al agua dentro de múltiples territorios para contrarrestar las relaciones de poder existentes y reducir las desigualdades y los riesgos.

El principal resultado de este análisis muestra redes de múltiples actores e instituciones, que van desde los organismos internacionales, las empresas privadas, las organizaciones de nivel macrorregional y las organizaciones nacionales, hasta los gobiernos locales, las comunidades y los actores de la sociedad civil. A diferencia de muchas ciudades en otros lugares, los gobiernos locales de Lima tienen poco que decir sobre el servicio de agua. La principal conclusión es que una red dominante establece los argumentos, las normas y su aplicación, aunque las relaciones de poder se están renegociando. Las redes emergentes que fortalecen los mecanismos judiciales y de control están incluyendo lentamente a comunidades más amplias, pero su poder sigue siendo limitado. Esta configuración se enfrenta a la paradoja de que las demandas actuales de agua de todos los usuarios combinados pueden ya no ser viables dentro de los límites ecológicos y las consecuencias futuras del cambio climático.



Nota: el color de las cajas es sectorial: urbano (marrón), agua (azul), riesgo (rosa) y medio ambiente (verde).

Fuente: Autor, versión actualizada de noviembre de 2017 basada en Miranda, Baud y Pfeffer (2016)

En cuanto a la segunda pregunta de investigación, en el capítulo cinco se analizó la forma en que los diferentes discursos influyen en los procesos[7] de creación de conocimientos, en lo que respecta a las principales preocupaciones, los límites del sector del agua, las tarifas del agua y los tipos de información que se consideran legítimos en Lima. Analizamos cómo los procesos de cartografía iterativa, dentro de tres procesos de concertación e investigación-acción en Lima, revelan geografías desiguales de vulnerabilidades e irregularidades relacionadas con el agua, presentando los resultados de procesos complejos de construcción social para generar, analizar e intercambiar conocimientos.

Mostramos cómo estos procesos están integrados en la configuración urbana y cómo la legitimidad de los procesos de cartografía debe ser negociada a través de diferentes escalas geográficas y límites institucionales.

La desigualdad se hizo mucho más visible al observar cómo los costos difieren entre los usuarios (urbanos, rurales y sectoriales). Un habitante de la ciudad de Lima que no esté conectado a los servicios de agua puede pagar 3,74 USD por m3, mientras que alguien que esté conectado paga alrededor de 0,83 USD por m3 a la empresa de agua, SEDAPAL. Al mismo tiempo, los usuarios del sector privado, como las minas y las industrias, pueden pagar sólo 0,08 USD dólares por m3 al mismo tiempo que utilizan enormes volúmenes de agua pura y cristalina, la contaminan, y generan altos ingresos (al Ministerio de Agricultura, a través de la Autoridad Nacional del Agua, ANA), lo que puede poner a la ciudad en un mayor riesgo de sequía y generar altos niveles de conflicto (Miranda Sara et al., 2016). Nuestra pregunta, aún abierta a discusión, es ¿por qué estas desigualdades permanecen?

La eficiencia económica tiene prioridad en estas decisiones, pero lamentablemente SUNASS (organismo regulador del servicio de agua potable) no evalúa a SEDAPAL por su ecoeficiencia, su equidad ni su sostenibilidad hidrológica a largo plazo, sino por sus beneficios económicos a corto plazo. Aun así, SEDAPAL proporciona niveles básicos de agua a por lo menos dos millones de habitantes en Lima a cambio de una tarifa subvencionada y, según dicen, a un costo de provisión más elevado. Proporciona mayores cantidades de agua a los usuarios residenciales que pagan más (y a los usuarios comerciales e industriales) y deja sin agua a más de un millón de personas sin conexiones domésticas; quienes dependen de camiones cisterna (un agua muy cara y de baja calidad). Con los actuales patrones de distribución y consumo, no hay agua suficiente para todos; incluso si SEDAPAL suministrara por igual 80ltrs/persona/día (cantidad recomendada según la Organización Mundial de la Salud) a cada habitante, su producción de agua potable no sería suficiente (Miranda Sara et al., 2016).

Una conclusión de la segunda pregunta específica de investigación es que los procesos de investigación-acción y de desarrollo de políticas pueden reflejar cómo se construyen socialmente los mapas de "riesgos y vulnerabilidades relacionados con el agua". En primer lugar, los mapas se basan en diferentes discursos y marcos conceptuales, entradas de datos y clasificaciones a múltiples escalas territoriales. En segundo lugar, visualizan las desigualdades

[3] El primer proyecto fue dirigido por un programa de investigación financiado por Alemania, LiWa, que desarrolló escenarios de cambio climático y modelos de simulación de agua. El segundo fue el comité de la Municipalidad de Lima para las estrategias de adaptación al cambio climático y el tercero el proyecto de investigación Chance2Sustain (C2S), que abrió un debate sobre perspectivas más espaciales en el desarrollo de la ciudad y la gobernanza del agua. Estos tres proyectos se desarrollaron casi en paralelo en el tiempo.

vinculando múltiples dimensiones, construyendo una comprensión más integrada de las dinámicas y diferenciación territorial del "paisaje fluvial" de Lima, combinando los procesos humanos y naturales. Esto, a su vez, contribuye a legitimar el debate entre diferentes tipos de conocimiento entre los actores. En tercer lugar, los mapas facilitan "el intercambio sobre prioridades, conflictos y sinergias", aportando insumos a los procesos de negociación entre los actores en las configuraciones de la gobernanza del agua. Dicho esto, es necesario asegurar la incorporación de esos procesos de cartografía en la formulación y aplicación de políticas para su más amplia aceptación.

Mi tercera pregunta de investigación fue en qué medida los procesos de *concertación* intercambian conocimientos, crean confianza y facilitan la planificación conjunta (y cómo contribuye a ellos la (ex)inclusión de diferentes tipos de conocimiento). En el capítulo seis, los mismos tres procesos fueron analizados en términos de las consecuencias de los escenarios plausibles de cambio climático de Lima. Al exponer los riesgos relacionados con el agua que se atribuyen al cambio climático, examinamos qué contribuciones podrían hacer los procesos de construcción social del conocimiento a las estrategias de adaptación al cambio climático. Se centró la atención en la medida en que los procesos de *concertación* incluían una gama más amplia de actores, discursos y conocimientos en la gobernanza metropolitana y en cómo éstos influyen en cambiar las prioridades de la toma de decisiones.

Aunque estos procesos utilizaron la *concertación* y la construcción de conocimiento social, los actores y tipos de conocimiento incorporados fueron diferentes. Mientras que LIWA siguió dominado por grupos profesionales y conocimientos técnicos experto, el Grupo Técnico de Cambio Climático de Lima y los procesos de Chance2Sustain incluyeron una gama más amplia de actores, de conocimientos y prácticas de la comunidad, avanzando hacia transiciones en el pensamiento sobre la gestión adaptativa y la construcción de conocimientos.

Ningún actor tiene todo el poder sobre el desarrollo de una ciudad. Esto es particularmente cierto en una ciudad metropolitana como Lima, donde el conocimiento está disperso y fragmentado entre muchos actores, quienes carecen de una visión global de la situación actual y menos aún del futuro de toda la ciudad. Los actores no tienen necesariamente que saberlo todo sobre cada sector o sobre toda la ciudad, por lo que el enfoque de esta investigación fue cómo se construye, comparte y utiliza el conocimiento, así como la forma en que éste fluye y ayuda (o no) a crear un entendimiento mutuo entre muchos actores, para que puedan no sólo comunicarse, coordinar, sino también "*concertar*", ponerse de acuerdo.

Una conclusión fundamental de la tercera pregunta de investigación fue que los actores pueden establecer acuerdos, incluso teniendo diferentes discursos, aportando conocimientos de diferentes escalas territoriales y niveles institucionales e iniciando acciones de colaboración a lo largo del tiempo, proporcionando insumos para la construcción de escenarios en las ciudades hacia futuras formas de adaptación al agua y al cambio climático. Sin embargo, esos procesos pueden incluir fuertes discusiones, conflictos y el reconocimiento de los discursos de otros, y pueden requerir la inclusión de muchos conocimientos (expertos, codificados, tácitos y contextuales) para construir escenarios capaces de "visualizar" y anticipar lo que podría suceder cuando las condiciones cambien en el futuro. Esos procesos requieren instituciones democráticas, transparentes y descentralizadas, que proporcionen mandatos firmes y la voluntad política que los respalde, de modo que las opiniones de los pobres y los vulnerables se incluyan y puedan hacerse oír.

En el Capítulo Siete, analizo la cuarta pregunta de investigación específica sobre la forma en que la construcción del conocimiento y la percepción del riesgo sobre los desastres

relacionados con el agua y las vulnerabilidades afecta a la toma de decisiones y a la implementación en las redes del gobierno urbano, examinando específicamente algunas de las razones que subyacen a los altos niveles de tolerancia al riesgo y a la falta de iniciativas para poner en marcha medidas de adaptación y/o prevención.

Se analizaron dos estudios de casos, que ya son o pueden convertirse en desastres. El primero se refiere a un análisis de los escenarios de cartografía territorial a largo plazo de la escasez de agua y sequía para 2040, combinando las tasas de crecimiento de la población y la distribución y el consumo de agua mediante Chance2Sustain. El segundo se refiere a los eventos climáticos extremos de corto plazo que se manifiestan recurrentemente como deslizamientos de lodo e inundaciones asociados (o no) con El Niño al Este de Lima, en Chosica. El análisis se realizó tanto a escala de ciudad metropolitana como de un distrito y comunidad vulnerable, ilustrando un proceso iterativo de construcción de conocimiento territorial, donde se produce la priorización de riesgos, la normalización y la tolerancia, con la consiguiente [in]acción de los actores. El conocimiento sobre las amenazas y las posibles acciones para la reducción de riesgos no se previeron hasta que ocurrieron los desastres en 2017.

La metodología utilizó procesos de cartografía colectiva e iterativa, utilizando conocimientos técnicos, organizativos y geográficos de una variedad de redes de gobernantes, expertos y profesionales en Lima. El principal resultado fue el aprendizaje social derivado de reunir diferentes tipos de conocimiento e integrar varias dimensiones a través de representaciones espaciales. Esto ha aumentado la concienciación, ha incrementado la capacidad para hacer frente a la incertidumbre y ha contribuido a la estrategia metropolitana de adaptación al cambio climático aprobada, pero no priorizada por la municipalidad de Lima hasta que el recién elegido alcalde asumió funciones el 2019.

Se sacaron dos conclusiones en relación con la cuarta pregunta de la investigación. Una, la planificación espacial es un proceso político, en el que los conocimientos se impugnan o incluso cuando se reconocen, no necesariamente dirigen los procesos de adopción de decisiones, ya sea por parte de las comunidades locales, las autoridades y las instituciones privadas. Dos, los modelos existentes que vinculan la construcción del conocimiento con el marco de la gestión del riesgo, la tolerancia al riesgo y la forma en que esto influye en los procesos de adopción de decisiones y las medidas para prevenir los desastres pueden hacer caso omiso a la tolerancia al riesgo, a través de la normalización y el establecimiento de prioridades, dejando a su cuenta y riesgo a la población.

Volviendo a la cuestión principal de la investigación, la conclusión principal fue que el conocimiento se desplaza más fácilmente en redes híbridas multiactorales y multiinstitucionales (y transdisciplinarias), cuando los mandatos y las políticas públicas (*concertadoras*[8]) se apoyan en información transparente como requisito previo. Esos procesos deben ser ciclos iterativos e interactivos en constante evolución de la dinámica.

La utilización de la configuración de la gobernanza del agua como marco conceptual principal permitió reconocer territorios y trayectorias del agua multiescalares y mostrar la falta de conexión entre la ciudad, la macroregión y los niveles más amplios del ecosistema.

[4] Una variedad de agentes participan, incluso en procesos de carácter obligatorio, en los que se aprende haciendo, se construye un conocimiento colectivo a través de diversas discusiones, espacios de diálogo y a través de redes sociales.

Este marco conceptual sobre la gestión de las aguas urbanas se vinculó a los debates sobre la construcción de conocimiento, que proporcionan información sobre cuatro aspectos principales. El primero de ellos se refiere a las desigualdades experimentadas en cuanto a qué conocimientos se aceptan y se consideran legítimos. El segundo se refiere a la forma en que la espacialización, o cartografía del conocimiento puede contribuir a hacer más visibles las desigualdades, fragmentación y centralidades en "territorialidades" en la práctica. El tercer aspecto se refiere a las formas en que las percepciones del riesgo se vinculan a la gestión adaptativa y a la forma en que los diferentes conocimientos se incorporan a esos procesos. Cuando se normalizan los riesgos, aumenta la posibilidad de que se produzca un desastre. El cuarto aspecto es que la vinculación de las cuestiones de la construcción de conocimiento con la configuración de la gobernanza del agua metropolitana contribuye a una mejor comprensión de las complejidades y las incertidumbres a las que se enfrentan los actores del cambio climático y aquellos que desean abordar estos temas.

Por último, las recomendaciones para futuras investigaciones y los vínculos políticos que surgieron se enmarcan aquí como nuevas preguntas:

- ¿Cómo podemos construir estructuras de gobernanza del agua inclusivas e interactivas de múltiples actores, de múltiples escalas, de múltiples niveles y multitemporales para nuevas configuraciones de ciudades metropolitanas a prueba de clima?

- ¿Cómo podemos dirigir y articular los procesos de reducción de riesgos, adaptación y anticipación para un futuro incierto y desconocido?

- ¿Cómo podemos coordinar la participación y los espacios inter-institucionales (entre defensa civil, la gestión de cuencas de los ríos y el uso, ocupación y transformación del territorio urbano-rural-natural) con los escenarios de cambio climático?

- ¿Cómo podemos desarrollar la voluntad política para garantizar un suministro de agua equitativo a largo plazo?

Foreword

The years 2016-2017 were difficult for Peru. In December 2016, the country was recovering from forest fires due to drought (mainly in the Andeans). Then, in March 2017, (mainly along the coast), the intense rains began, provoking mudslides, landslides, drainage overflows, floods, hailstorms, rains, lightning storms, strong winds and even snow in the mountains. Two climate change scenarios in a period of fewer than six months: drought and heavy rain.

It was a bitter time, marked by El Niño Costero, a disaster caused by the warming of the sea which struck until April 2017. Climate change is already making an impact in Peru, and people are suffering its consequences all the more for struggling to accept that a changeable and uncertain climate is the new norm. What would have once been extraordinary is a new normal. Meanwhile, ENFEN (the National Commission to study the El Niño phenomenon) announced that in 2019 a new El Niño was coming again, albeit a moderate one.

It is worth mentioning that warnings were made and then repeated again and again (Chapters Four, Five and Six were published before these events took place). In Peru and the Lima metropolitan area, we saw once again that prevention was insufficient: housing, means of subsistence, roads, bridges, water channels and other infrastructure were destroyed (almost six million people were left without water over five days in Lima alone). The country's GDP fell by several points, unemployment rose, and 380,000 people returned to poverty that year (180,000 in Lima), further to the high cost of reconstruction, around 7 billion US dollars. Things are slowly getting better, but a lot of effort and funding has been lost, not to mention the human losses.

In this way, the disasters of 2016 and 2017 increased visibility and mobilised agreements and change. In 2018, the Peruvian government passed the Legal Framework for Climate Change, Law No. 30754, a unanimous decision in Congress, to assure the integration and transversality of the climatic component in public policies and investment projects. This law recognises that adaptation to climate change requires an integral, transversal, multi-sectorial, multi-factorial and participatory management, and it establishes a new, favourable constitutional framework in which the municipalities can count on clear mandates in the face of climate change. Regardless of this positive step, work has only just begun on this issue and it will be some time before we see it evident in practice.

Increased water-related vulnerability is having particular effects on the city of Lima and its metropolitan area, with extreme events and situations affecting the city with increased frequency, longer duration and worsened impacts, as seen in Table 1. New zones, once safe, are being found at risk and had yet to see the effects of El Niño 2019.

Table S.1: Long-term trends in Lima water-related disasters

January 1970 (all Lima)	**March 1987 (Chosica)**	**February 1998** **(Chosica up to the Rimac River)**	**2012 + 2014 and 2015 (Chosica, Chaclacayo and Ate)**	**March 2017 Coastal El Niño** **(all Lima)**
It rained for 5 hours 17mm (normally 9mm rain in a year) Over 2 million houses affected Fires (150) Lootings Jorge Chavez Airport damaged, Lima isolated (aerial bridge Huaraz – Lima).	It rained intensely various times and there were landslides **100 people died** 1,052 houses were damaged 3,000 people were affected.	Avg. sea temp. 24.6ºC (ENSO) A mudslide reaches within 80m of the government offices in the historic centre. The river Huaycoloro burst its banks and almost reached Ave. Perú in the city centre The **torrent reached 1m in height** Looting Authorities prevented deaths.	Rains in February – March An anomaly (DANA) which travelled from the Pacific and came in from the Atlantic, pushing humidity towards the mountains, generating rains.	Various intense rains (in one it rained 7mm in 6 hours): landslides, floods, overflows, loose ground and rocks **2,186 injured, 3,699 affected** (INEI Census) and 12 dead (Region) 514 houses affected, collapsed and destroyed. 1454 in need or repair. 55 bridges collapsed and 77kms of roads out of service The hydroelectric plants in Callahuanca were covered in sediment.

Adapted from: Miranda Sara, L. (2017) based on O´Connor, H. (1988), Calvo, E. (2012), SENAMHI (2013), INEI (2017) and newspapers (2017)

The evidence of climate change did not receive enough attention. Climate change begins in cities, via greenhouse gas emissions due to energy consumption in buildings and from transport and industry. It is in cities that adaptive capacity is defined; for example, the municipality of Lima, supported by the Cities for Life Forum, passed its climate change strategy.[9] Two of the strategy's priorities are to promote green densification and sustainable infrastructure and construction, to become an adaptable city. In the case of Lima, reducing the vulnerability related to water and hydro-climatic disasters has been of utmost importance. Unfortunately, the municipal management of 2015-2018 has implemented the strategy slowly, not considering the risks attributed to climate change which the city faces, particularly its poorest inhabitants (as seen in the table above).

Effects caused by the El Niño Costero or by lack of knowledge and governance?

Lima and Peru's vulnerabilities are institutional. It is worth asking ourselves: are disasters an effect of the power of nature, or the power of *knowledge or the lack thereof* (and the resulting poor prevention and/or absence of planning and coordination)? Climate change is global and systemic and requires adapting the climatic institutions and governance of the country, particularly regarding water and cities. The vulnerability of Lima, current and future, starts with its governance and continues with (*re)knowing* about current and future risk on behalf of multiple actors within the metropolitan city.

[9] Ordinance 1836 - MML 2014

Hazards are natural, but disasters are not. Disasters are socially constructed. Despite all the progress made, the studies written (LiWA, C2S), the plans and strategies approved (PLANAC, ERCCL), the management instruments published (PLAM 2035, not yet approved) and scientific publications, neither Lima nor Peru were prepared. In 2017, Lima, the cities in the north, the highlands and the jungle were left without water and suffered food shortages, and thousands of people were left without homes, with no roads or bridges to escape. What then was the cause?

This emergency brought to light the lack of knowledge, coordination and the low perception and high tolerance with cognitive dissonances when facing risks attributed to climate change scenarios. Similarly, an absence or limited presence of long-term planning was made clear. Among the most important areas affected by disarticulation and sectorialisation were instruments of territorial management, such as upper river basin areas, human consumption of water itself, land use in cities and risks (as chronic, climate-related and disasters). Above all, the weakness and fragmentation of the country's institutions and governance were highlighted.

The Law 29664 - Law of the National System of Disaster Risk Management ('SINAGERD', part of PLANAGERD) was ignored. We noticed the absence, or solely decorative existence, of instruments to reduce risk for local and regional authorities. Furthermore, the lack of awareness of and little value given to the National Policy for Climate Change and its instruments was evident. It was clear how rarely long-term planning is conducted in the country, and how little value is given to urban planning and the integrated management of water resources laid out in the law. To make matters worse, the experts and members of these scientific communities have not worked together, or have been late in doing so and, worse still, the articulation of their concepts and proposals is not reflected in the work of the state, the private sector and, even less so, in communities and amongst vulnerable peoples (those chronically in risk, but even less among those newly exposed to these risks).

Additionally, the fragmentation and centralisation of the Peruvian state were revealed: the difficult coordination amongst civil service workers who manage river basins with those in charge of drinking water, drainage and sanitation in cities. One could see the difficulties of urbanists and urban planners in articulating their analyses and proposals for a wider territorial approach. It also became obvious that amongst communities and populations, particularly the poorest, there was a marked ignorance of the level of risk in which they were living and how this affects them and keeps them in poverty.

This emergency was caused by a **hydro**-climatic phenomenon and required the development of these concepts and approaches and management instruments to reduce risks, acting ahead of time and in an articulated and coordinated manner. If, in addition to this, one could add social policies and a reduction of poverty, then, even with some difficulty, one could reduce the daily or chronic risk suffered by the most vulnerable people. An institutional risk management and climate change framework in place might have helped to reduce risk and put in place processes of comprehensive development with a long-term outlook.

The challenge remains in the climate risks and risk management approach, as much that of the state's institutional structure as that of governance. Climate change is global, systemic and requires that a country's institutions and climatic governance adapt, particularly regarding water and cities. Climate change requires comprehensive, transverse, multi-sectoral, participatory and *concertación* management towards new climate-proof governance configurations.

How can we help the 're'-understanding of this new normal? What is missing? Is it true, reliable, objective and scientific information, with input and knowledge from a wide variety of people[10]? Making decisions in governance brings together different groups, involves multiple actors, is multi-sectoral and is decentralised, being present at every territorial scale, and thus makes use of multiple types of knowledge.

To achieve these ends, there is a need for continuous information that is transparently monitored. This information must be presented in such a way it can be understood by anyone, however much they know about climate change. Such information must be free from political bias, non-partisan and unaffected by conflicting interests. This information and knowledge can be used to make decisions which allow us to prevent and adapt to future issues, take advantage of opportunities which come up and prepare us for the climatic scenarios to come.

The approach of those instruments commonly used in the management of disaster risk in Peru needs to change. These instruments do not question the causes, the underlying or base factors of risk in which vulnerable (and generally the poorest) populations live, and unfortunately, they have been limited to only reducing the effect of natural or man-made phenomena. This approach, when used in post-disaster funding, returns things to how they were before, perhaps a little better, but without considering that climatic phenomena are cyclic and reiterative, part of a continuous process of climatic variability of the new normalcy, normalcy getting worse. These phenomena exacerbate the processes of social risk construction and are closely tied to poverty and inequality. They are evolving and transforming as time goes by and different climatic scenarios occur. Evidence and experience show that, contrary to improving things, reconstruction tends to increase risk.

Therefore, this fragmented and uncoordinated approach without a long-term vision is not helping. The emergency is affecting us systematically and repeatedly. The El Niño phenomenon is cyclical and climate change scenarios are a fact. To continue funding and reconstructing with effectiveness, we must consider the new conditions of this new climate normality, and we must redesign and reconstruct for future climates. It would mean durable investment so that further costs due to the recurring impact of unprevented disasters are avoided. Now that work is being done in response to the latest disaster, there is a danger of once again reconstructing the same risk conditions.

If political will already exists at a national level, which can lead the way and take on the role of protagonist in seeking the reduction of disaster and climatic risk[11], then an articulated, territorial and integrative approach is necessary which must deal with the causes and origins of risk and vulnerability. For example, we can draw attention to the fact that neither the National Water Authority (ANA) or the Environmental Ministry (MINAM) are part of the Reconstruction Authority (RCC) and do not appear to have been consulted nor mentioned during the emergency, despite it having been **hydro**-climatic in nature.

The other key point is the financial budget: why is there still so much resistance to integrating actions proposed in regional, municipal and sectoral plans and budgets for prevention? An iconic example is that of the former mayor of the Metropolitan Municipality of Lima (MML), in which 85% of the prevention program's budget was spent on a walkway and cycle path along the Costa Verde (Lima's Green Coast). This was a case of building with risk since

[10] Making the local wisdom of indigenous peoples and rural communities compatible with scientific methods

[11] The Climate Change Framework Law (Law 30752) was passed unanimously by congress in 2018, evidence of unanimous political backing to deal with these new conditions

coastal erosion could mean the collapse of the project within a short period. A report by 'Ojo Público'[12] showed the problems regarding the costs of regional government projects. What it did not show, however, was the negligible amount given to risk prevention as part of the state's total budget. While Japan spends 7%[13] of its annual budget on prevention, Peru does not even manage 0.7%. The subjects deserve a permanent space for debate and observation to guarantee that more is invested and that it is well-invested - taking into account **the causes of risk** in an articulated way, especially since so little spending is allocated to long-term planning and effective prevention.

Focusing on rights and dealing with the causes which generate risk

Lima has seen how climate change and climatic risk affect various groups of people differently, but the state must guarantee rights to all[14]. The focus on rights permits the management of public policies to be administered so that inequalities do not grow; on the contrary, this focus can generate actions which balance out these inequalities, therefore reducing risks. The focus on rights also helps us to understand that the risks of some are also risks to all since we all lose.

When municipalities authorise (or 'approve plans') which allow the occupation - through changes to land use, urban habitation licenses or building licenses - of zones of unmitigable high danger or recurring risk: they are expanding risk. When regional governments do not prioritise funding for urban drainage or decent-sized sewers, such as was admitted by the former governor of Piura[15] in his institutional portal, they are contributing to the expansion of risk. When a company constructs, with or without authorisation, in a riverbed or a dry ravine, they are expanding risk. When the Housing Ministry (MVCS) does not pass a regulation to provide a map of dangers with the allocation of land use in the Urban Development Plan which would sanction those who did not comply with it, they are expanding risk. When the Transport Ministry (MTC) allows a road to be built without including in the contract a clause of insurance against disaster risk, they are expanding risk. When a resident buys a parcel of land from a land trafficker, on a steep hillside, or in a riverbed or on a bank of scree, they are expanding risk. When the central, regional or local government does not provide information on high, immitigable risk, nor recurring risk, nor do they give technical consultancy or sufficient resources for prevention, they are expanding risk, and generally, those most affected are those who are most vulnerable, the poorest, who suffer systematically from chronic risk, from daily risk.

How can the behaviours of each actor, public, private and communal, be modified and corrected? How can we reconcile and '*concertar*' without losing principles (built-up socially supported agreements, decisions and to take actions) under the tensions of such different approaches, and how can we generate climate-proof water governance changes in metropolitan cities?

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[12] https://ojo-publico.com/401/las-terribles-cifras-del-nino-costero-nivel-nacional (visited 21.03.2017)

[13] Intervention by Arch. Linda Zilvert in a Peruvian Congress working meeting about the participation of civil society in the management of disaster risk

[14] Intervention of Fico Arnillas, President of the Peru *Concertacion* Tables to fight against poverty in a Peruvian Congress working meeting about the participation of civil society in the management of disaster risk (2017).

[15] '...our region has close to 50 endorheic basins, investment for which would require more than 1000 million soles (305 million usd), a figure which would take up 5 years of the regional infrastructure budget' http://www.regionpiura.gob.pe/index.php?pag=17&id=644&per=2017

We must strengthen the comprehensive governance of risk linked to development policies. The management of disaster risk reduction, articulated to the adaptation and anticipation in the face of risks attributed to climate change with the reduction of daily or chronic risk, is the strategic challenge to attain a comprehensive and conferring governance of risk linked to development politics.

This requires the tailoring of the national regulation to the international treaties and agreements of the United Nations Framework Convention on Climate Change and, even if it has not been mentioned in the Peruvian Law of Climate Change, The Paris Agreement[16], the Sendai Framework for Disaster Risk Reduction,[17] the Warsaw International Mechanism for Loss and Damage[18], the New Urban Agenda[19] and the Sustainable Development Objectives for 2030[20].

This requires the strengthening of capacity regarding the management of uncertainty and change for adaption, articulation and integration to make the flexibility and diversity of responses possible. This integration requires flexibility at an individual, organisational and systemic level and from each level (national, regional and local) the capacity to respond to unpredictable circumstances of change. Instead of basing itself on rigid, centralised systems of control which seek stability but erode and facilitate the collapse of socio-economic and physical systems, governance should use decentralised, autonomous systems. These increase resilience because systems can act faster and are more capable of responding to local needs and demands (Miranda Sara et al., 2014a).

[16] Visited 25/01/2017 https://ec.europa.eu/clima/policies/international/negotiations/paris_es, http://newsroom.unfccc.int/es/acuerdo-de-paris/el-acuerdo-de-paris-entra-en-vigor-tiempo-de-celebracion-y-de-realismo/, https://es.wikipedia.org/wiki/Acuerdo_de_Par%C3%ADs_(2015)

[17] Visited 03.05.2017. http://www.cenepred.gob.pe/web/notas-de-prensa/marco-de-sendai-para-la-reduccion-del-riesgo-de-desastres-2015-2030/

[18] 19.04.2018 http://170.0.177.4/phocadownload/planes-estrategias/cambio-climatico/Decision-CP-19-Mecanismo-perdidas-danos.pdVisitado

[19] Visited 19.04.2018 http://habitat3.org/wp-content/uploads/NUA-Spanish.pdf

[20] United Nations General Assembly, 'Transformar nuestro mundo: la Agenda 2030 para el Desarrollo Sostenible' (visited 18.07.2016) http://www.un.org/ga/search/view_doc.asp?symbol=A/70/L.1&Lang=S

Chapter 1. Introduction

Peru is among the ten countries which are most vulnerable to climate change (Adger et al., 2007), with the recurrent effects of El Niño (ENSO by its English acronym) exacerbating its vulnerability. Whereas metropolitan Lima, the capital city of Peru located in the Pacific Coast, with almost ten million inhabitants, suffers both high levels of water stress and flooding, with unequal distribution and setting of tariffs for water (Miranda Sara et al., 2016), it is the second driest city in the world after Cairo, and it is highly vulnerable concerning drought and disasters induced by heavy rain events. This makes Lima a relevant case to examine how water governance is configured in the context of current weather trends and plausible future climate change patterns.

Lima is also relevant because its combination of informal urbanisation, interactive governance processes around urban infrastructure, and complex environmental management already have a long history of several decades. In Peru, the institutionalised culture of participation has led to the much broader concept of *concertacion* and studying actual practices of collaborative planning and *concertacion* processes allow to analyse actors' abilities to build up socially supported agreements, decisions and take actions (*concertate*) to reduce risks, to adapt and anticipate uncertain and unknown futures concerning water-related risks attributed to climate change scenarios, which sadly started to become true in the summer of 2017 with the 'El Niño Costero' disaster.

Lima is also relevant because of the COP 20 held in 2014, which became a catalyst in such processes, prioritising 'sustainable cities' as one of its five emblematic themes under discussion. Before, changes happened very slowly. The 2015 municipal elections followed by national government elections shifted the city's and the country's political power to the right, with parties, who are associated with climate deniers, winning. The dramatic effects of El Niño Costero disaster (2017), the drought and fires (2016) and the Andean's frozen waves happening almost every winter are becoming new normal climate conditions in Peru. Together, these events contributed to the acceptance of Climate Change Law, Law No. 30754, as well as several other institutional changes still ongoing. It remains to be seen whether changes will occur after the new municipal authorities starting in January 2019.

This research focuses on metropolitan Lima´s (from now on, just Lima) complex water governance configuration, with its fragmented institutions, overlapping processes, high level of government centralisation, and corruption scandals facing the city.

Particularly in countries like Peru, whose economy relies on extractive economic activities, (mines, fish meal and agro exports), to support industrialisation, with both local and global impacts, extractive development is resulting in severe environmental problems and increasing vulnerability and risks for both cities and rural areas. Such 'development' and urbanisation processes are accompanied by the following: a) increasing inequality and exclusion; b) remarkable water-related climate vulnerability and risks; and c) centralistic, fragmented governance surrounded by corruption scandals. To change the unbalanced relationship between nature, territories and societies, in a context where climate change is changing future development scenarios, it is necessary to analyse the dynamics of economic, socio-political processes, as well as knowledge power to understand how decision-making is driving current (and future) outcomes, affecting not only the most vulnerable people but creating new vulnerable groups in various territories (urban, rural and natural landscapes).

Researchers are showing the incompatibility of the current growth model with the paradigm of sustainable development (Escobar, 1998, 2015; Gudynas, 2011; Santos, 2018; Swyngedouw et al., 2003). The constant dominance of economic matters over environmental and social issues is massively increasing global inequality (Gudynas, 2011) with the unprecedented destruction of ecosystems, which in turn perpetuate poverty and increase vulnerability and risk. So far, despite widespread efforts to reduce poverty, El Niño Costero has pulled back Peru's achievements made in poverty reduction. Currently, the Peruvian government has set a new sustainability agenda indicating the urgency of revising current global economic growth model to reach the ambitious targets they set by adopting the sustainable development goals (SDGs).

Despite the introduction of ideas about the green economy, circular economy, corporate responsibility and B companies, economies have not been able to regulate or shift the increasingly unequal development which is destructive of the natural environment and resisting or denying the role of climate change into our present and future. The concentration of economic and political power in the hands of a few actors perpetuates the model and is systematically obstructing the inclusion of the needs and expectations of poorer people and the natural environment in political agendas. It is only after facing the effects of disasters that the power of nature is acknowledged, and actors start acting upon all these circumstances (Castro et al., 2016; Escobar, 2015; IPCC, 2019).

Water issues are a strategic area at the forefront of international discussions on global futures, both as a natural resource and as risk-vulnerability. The report by the Water Resources Group (WRG) confirms this, stating that by 2030, under a scenario of medium economic growth with no efficiency improvement, global water needs will increase by 4500 million square meters to 6900 million square meters (WRG, 2009). This is 40% above the current supply (including return flows and considering that a big part of the supply is reserved for ecosystems and other species). This global percentage is the sum of a huge number of local rivers and lakes, some of which are in a bad state: a third of the population, concentrated in developing countries, live in basins where the shortage will be more than 50%.

The IPCC fifth assessment report (2014b)[21] argued concerning the water cycle that changes occurring in the global water cycle in response to the warming in the 21st century are not uniform. The same report stresses the difference in rainfall patterns between wet and dry regions and between wet and dry seasons, although regional exceptions exist (IPCC, 2014b). Literature also pointed out that there is a high level of confidence that the El Niño/Southern Oscillation (ENSO) phenomenon will remain the dominant mode of yearly variability in the tropical Pacific, which will have a global effect in the 21st century (Alfieri et al., 2013; French et al., 2017; Hirabayashi et al., 2013; Morera et al., 2017). Peru is confirming that variability of rainfall increases related to El Niño.

The IPCC fifth assessment report (2014b), the 1.5°C Special Report of IPCC (2019) and the Sendai Framework (2015) also highlight the need to link climate change, risk reduction and socio-economic development, where ending poverty and stabilising the climate are the two main challenges of this century, with the potentially greater effects of climate change being already an obstacle to poverty reduction. The Sixth Assessment Report of IPCC is finally

[21] By the time I was finalising my thesis the IPCC 6th Assessment Report was being concluded and it was too late for being included into this thesis.

including a chapter on cities underlining how the people hardest hit[22] will be those living in informal settlements in low- and middle-income countries, where greater and more vulnerable agglomerations continue to grow (Miranda Sara, 2015a; Rosenzweig et al., 2018). The Paris Agreement and the Sendai Framework, together with Sustainable Development Goals, share objectives to strengthen resilience, build adaptive capacity and reduce vulnerability to climate change and disasters, pursuing cities' sustainable development and creating a strong rationale for alignment. Science alerts[23] about mean temperature rises affecting cities and water availability are already evident in cases like the drought alert in Cape Town in 2018, the recurrent droughts in California and Sao Paulo, water stress in Syria and many rivers affected by water scarcity and quality issues. These examples showcase, among others, the intrinsic relationship between climate risks, cities, water and development.

The relation between water and cities is found through an understanding of the urban water cycle which involves all water sources, such as the atmospheric supply (from various forms of precipitation, such as fog), the lineal sources (springs, streams, channels and rivers), water masses (lakes, reservoirs, seas, oceans and wetlands), subterranean waters (aquifers and subterranean flows), treated wastewater (aerated lagoons, decentralised systems and domestic systems) and understanding that these water sources do not operate in isolation, they are instead part of a system and one single hydrological cycle.

Cities' water-related vulnerabilities are related to existing socio-economic inequalities as well as environmental phenomena related to climate change. Vulnerabilities concern unsafe areas due to environmental risks such as floods or mudslides as well as people's lack of access to better living conditions (safe housing, clean drinking water, sanitation) (cf. *Environment and Urbanization* 2015: vol. 27, no.2). Such conditions are exacerbated by the effects of climate change, including the El Niño System Oscillation (ENSO), which changed water temperatures, rainfall patterns, water currents and fish stock availability as happened in the 2017 Peruvian summer (NOAA, 2015; WMO, 2015). Climate change is also bringing unknown realities which need to be anticipated.

Although Peru was declared an upper-middle-income country in 2015 (World Bank, 2016) since 2017 it is currently undergoing an economic recession, linked to water-related disasters. In 2018, the government recognised that poverty was increasing again, with 380,000 new poor, 1,3% GDP loss and only 2% economic growth after El Niño Costero, without mentioning the deaths and destruction costing 6 to 9 billion US dollars, 114 deaths, more than a million inhabitants affected, 6614 km of roads damaged, 326 bridges and 41,632 homes destroyed or uninhabitable, and 242,433 homes, 2,150 schools and 726 health posts damaged. Costly reconstruction is still ongoing (French et al., 2017).

Having said this, still, Lima´s prior vulnerability is institutional, with Lima´s water governance configuration not able to protect the city nor prevent the disaster (see Table 1 in Prologue). This is related to a lack of long term planning and integrated water and risk management, low coordination, climate risks and climate change scenarios being ignored by residents, private sector and decision-makers alike, particularly when the budget allocation for preventive actions was necessary (Allen et al., 2016). Only after several disasters, affecting also those in power, have dominant actors lost influence and are prepared to initiate changes.

[22] Such as higher temperatures, heat stress, water insecurity or extreme weather events affecting a higher number of people exposed to these events, in particular urban and rural poor communities.

[23] Mean annual precipitation in the 100 ARC3.2 cities around the world is projected to change by -7 to +10% by the 2020s, -9 to +15% by the 2050s, and -11 to +21% by the 2080s. (Rosenzweig et al., 2018) http://uccrn.org/files/2015/12/ARC3-2-web-small.pdf (visited 09.06.2018)

But, at the same time, no single actor has power over a city´s development. This holds true particularly in a metropolitan city such as Lima where knowledge is dispersed and fragmented among many different actors, who lack an overview about the present situation and even less about the whole city´s future. Of course, actors do not necessarily have to know everything about every sector nor the whole city, for that reason, the central issue in this research is how knowledge is constructed, shared and used, how knowledge travels and helps (or not) to build up mutual understandings among many different actors, so they can not only communicate, coordinate, but *concertate,* understood as a way to build up socially supported agreements, take decisions and coherently act upon them.

This research has benefitted from the existing culture of *concertación*, which provided inclusive spaces[24] in which more and more types of actors could meet to debate issues, negotiate solutions and develop proposals for action. *Concertacion*[25] can be seen as another form of social learning (Miranda Sara et al., 2014). This research is embedded in the debate on social learning in cities as an important means or instrument for dealing with climate change (Pelling, 2011), institutional development and governance networks configurations (Gupta et al., 2015; Torfing et al., 2012). Social and organisational learning is seen as essential for system survival, and both planned actions and responses to unexpected shocks are necessary. But there are barriers to social learning, expressed in the institutional arrangements which are based on different actors' ideas, beliefs, languages and discourses, the types of knowledge included or excluded, actors' power imbalances and their different interests, expressed in the outcomes and *concertacion* processes (Miranda Sara, 2004). These learning and participatory processes are not as easy and fluid as the literature often suggests, so to acknowledge barriers provides a more realistic picture. Knowledge is not shared nor exchanged without restrictions, social learning is even prevented in certain circunstances, contributing to greater disasters due to the lack of integrated water management, or maintaining unequal water provision, distribution and tariff-setting, which affect more the powerless and misinformed, generally poorer and vulnerable people.

So, to tackle the main issue of this research, it was necessary to find out ways and strategies which may drive new multi-scalar climate-proof metropolitan water governance configurations. More broadly, for achieving that, I aimed to find out how to reconcile and to *concertate* without losing principles under the tensions of very different discourses, approaches and understandings of the current water situation and uncertain futures in Lima, which in turn may generate climate-proof water governance changes in other metropolitan cities' configurations. In other words, I aimed for insight into how effective governance networks are built up, in which citizens and civil society organisations participate and mobilise actively to obtain particular goals. Discussions are generally focused on how government and non-governmental actors work together and on the idea of governance networks which is now generally accepted (Baud et al., 2008; Torfing et al., 2012). More recent studies focus on the concept of hybrid arrangements in which issues of non-recognised actors, networks at multiple scale levels and the dynamics of the processes involved, have been the focus on discussion (Baud et al., 2014). Through such arrangements, the issue of

[24] Inclusive spaces are spaces of trust where mutual understanding is sought to encourage key actors to fully participate in building consensus on agreements, reduce conflicts among the group, and receive/welcome new sources of knowledge.

[25] Key characteristics are learning-by-doing, combined with the construction of knowledge through various social networks. The latter implies the validation (or contestation) of the knowledge of a variety of participating actors, and a highly sensitive and complex process of dialogue–negotiation– *concertación*–conflict management and consensus-building (or not). Such processes can be seen as constantly evolving cycles.

whose knowledge and what kinds of knowledge are built up and recognised, becomes a critically important issue to understand and utilise for tackling water issues in practice.

Following Peyroux et al. (2014), I used the concept of spatial knowledge management configuration (SKMC) as an ensemble of i) discourses; ii) actor coalitions and/or networks and their power relations within decision-making processes (with a multi-actor approach); and iii) the main processes of knowledge generation, use, exchange and contestation, and (their) spatial knowledge platforms and products produced and utilised (ICT-GIS-based products; maps) (Baud et al., 2014; van Buuren, 2009).

The underlying assumption is that the iterative construction of knowledge (implying data gathering, analysing and exchanging in an inclusionary manner) can foster the move from sectoral and fragmented to more integrated planning. In this way, to understand the role that knowledge management and inclusionary processes could play in facing the challenges in the multi-scalar territorial dimension of governance is of particular importance to water governance, given that metropolitan cities depend on water sources well beyond their city boundaries (see Chance2Sustain Thematic Reports 4 and 5, dates). The policymaking process in cities is also shaped by legislation and policies at higher levels of government. This research addresses the question of the extent to which actors in water governance take this multi-scalarity into account, as well as whether and how linking knowledge to geographic scales (spatialising) can improve the understanding of the territorial (not only river basin) dimensions of water governance. The research adopts the perspective that building up such knowledge can support inclusive scenario building processes to envisage the plausible consequences of climate change on existing water vulnerabilities.

Main research question

This study, therefore, tackles the question of how Lima´s water governance networks are being reconfigured in terms of discourses, power coalitions, territorialities and inclusionary knowledge building processes to face water-related risks, vulnerabilities and inequalities associated with climate change.

Chapter One has set the context in which this thesis is rooted. Chapter Two develops a theoretical overview discussing the main debates in current research and the sets of theory on which it draws: first, the new sustainability concept applied to water and territorialities, second, the water governance networks as configurations using, coalitions, process (*concertacion*), power and social construction of knowledge and third debates on how to deal with climate change in the future, combining disaster risk reduction with anticipation theories building knowledge through scenario analysis and transfer processes.

Chapter Three presents the specific research questions, conceptual framework, research choices and methodology applied. The specific questions focus on the actor networks involved in water governance in Lima, the geographies of water-related vulnerability and inequalities, how processes of knowledge construction can be built into participatory decision-making processes, and risk perceptions in constructing spatial knowledge around climate change scenarios. The research choices involved as a main methodological approach a participatory action-research with multi-actor involvement (different levels, sectors and timings), with a problem-solving focus being part of different processes between 2010 to 2018, with a break between 2016-2017 (due to El Niño Costero and my participation in the Environmental Commission in the Congress of Peru), combining roles as researcher and activist advocating change and contributing to generate policy products.

As stated, three processes of decision-making have been followed for the analysis. The first process concerns expert knowledge via a research project on water in Lima, LiWA (Schütze et al., 2019), the second relates to the participatory development of the climate change adaptation strategy of metropolitan Lima with the climate change technical group of Lima, and the third focuses on the Chance2Sustain research programme, conducting and analysing a series of focus group discussions and in-depth interviews with key city actors as well as with community groups. Research results of these three processes have been reported in the following four co-authored empirical chapters[26].

In Chapter Four, 'Configuring water governance: Actor networks, territorialities and outcomes in metropolitan Lima', the first specific research question is dealt with, concerning how Lima's water governance networks, territorialities and outcomes are configured. For identifying the actor networks, a multi-scalar, multi-level and multi-sectoral analysis cuts across the following: i) multiple actors (government, civil society, community, private sector, academia, politicians, international agencies); ii) multiple spatial-territorial scales (from the metropolitan city area to the local/neighbourhood and water sectors); iii) multi-sectoral (housing and sanitation, water, environment, health and energy and mines), as well as iv) at the multiple government levels (national, macro-regional, larger river basins councils, province and district municipalities); and v) following the flows of water, that is to say, the whole hydrological cycle in Lima´s territorialities.

The concept of governance configuration developed by Baud et al. (2015) was applied to the water institutional arrangements in metropolitan Lima. I based the analysis on various water discourses, identifying four actor networks, their power interactions, under a multi-scalar territorial perspective to delineate the outcomes (in terms of universal water provision and sustainability of the hydrological cycle). The main conclusion is that one dominant network sets discourses, rules and implementation, although power relations are renegotiated. Emerging networks include wider communities, but their power remains strongly limited. The network configuration faces the paradox that current water demands of all users combined may no longer be feasible within ecological limits and future climate change consequences.

Chapter Five, published as a chapter in an edited volume by Bell et al. (2017), I analysed the second specific question of this study; namely, how do mapping processes built up through iterative knowledge construction in *concertación* processes in Lima reveal uneven geographies of water-related (climate change) risks, vulnerabilities and inequalities in cities (and territories)? In this chapter, the urban geographies of water-related vulnerability and inequalities are outlined, recognising risk in knowledge building processes in Lima, Peru. The three research and policy-building processes in which the author was involved and mentioned above were analysed, reflecting the variety of ways in which understandings of 'water-related vulnerabilities and risks' are socially constructed. The incorporation of spatial analysis has contributed to a more comprehensive understanding of water-related inequalities, vulnerabilities and risks, across the boundaries of metropolitan governance configurations. They have also contributed to raising awareness and increased knowledge among actors in Lima's water configuration on the different discourses and ways of thinking when dealing with the uncertainties of uncertain and unknown futures.

Chapter Six, published as an article in *Environment and Urbanization* (Miranda Sara et al., 2014), deals with the third specific question of this research, concerning the extent to which

[26] I did entirely the research and writing for all four chapters, the co-authors/supervisors helped in developing the conceptualisation of the research and structuring and editing of the chapters.

concertación processes exchange knowledge, build trust and enable joint planning (and how the (ex)inclusion of different types of knowledge influence them). This concerns knowledge-building in the *concertación* processes designed to transform Lima water and climate change governance. Comparing the three different processes of knowledge building mentioned above, this chapter examines how these processes of knowledge construction contributed to transitions in water governance and climate change adaptation strategies.

The main conclusion about these *concertación* processes is that actors can build agreements on collaborative action over time even if they have diverging water and development discourses and different territorial and metropolitan city visions. Such processes include conflicts as well as recognition of the others' perspectives and require contextual-embedded knowledge as well as expert, codified knowledge to build up city scenarios capable of 'seeing' what might happen when conditions change in the future. Although discourse mobility is limited by strong interests, the research processes showed that the scope for social change remains. However, democratic and decentralised institutional frameworks, providing strong mandates and political will are required if the views of the poor, vulnerable and excluded are to be heard.

Chapter Seven analyses the last specific research question about how knowledge construction and risk perceptions of water-related disaster risks and vulnerabilities affect decision-making and implementation in urban governance networks (analyzing some reasons behind high levels of risk tolerance and the lack of decision-making initiatives in putting adaptation and/or preventive measures in place), was published in *Habitat International*. The main conclusions were that spatial planning is a political process, in which knowledge is contested or, even when acknowledged, does not necessarily steer decision-making processes. A second conclusion was that existing models linking knowledge construction to risk framing, risk tolerance and decision-making processes and actions to prevent disaster, ignore risk tolerance through normalisation and prioritisation at their peril.

In Chapter Eight, the conclusions of this research are summarised. Although each chapter has its own conclusions, this chapter develops an analytical, systematic and updated version of them. Furthermore, I present how configuring climate-proof metropolitan water governance, iterative knowledge building, risk perceptions and governance networks inclusionary processes (*concertación*) may contribute to generating climate-proof water governance and new changes, not only in Lima´s metropolitan city configuration but also how this analytical approach can be used by other metropolitan cities in the world.

I cannot finish this text without recognising that I have faced three main difficulties or constraints. The first one is that you can not *concertate* without the achievement of a common understanding and shared knowledge being built among actors who need to manage the same level of information. But, knowledge *tends* to remain where it has been generated and information and knowledge sharing is still weak, with water-related and climate change knowledge fragmented, dispersed and/or ignored both in Lima and Peru as a whole. To overcome this, one of my main assumptions was that knowledge travels and mobilises easier in hybrid networks within interactive and inclusive processes with mandates and political support, but politics proved to be quite dynamic and unstable both in Lima and Peru.

The second main constraint of my research process, and probably the most important, was the high level of corruption (shown in the news and newspapers on Lava Jato scandal in Perú starting in 2018 and 2019 still ongoing) in the political environment in the country and Lima. It was a true barrier, corruption has become normalised and accepted and posing a clear

barrier to negotiating on an equal basis. The practice was those dominant actors negotiated and brought power-play dynamics into the processes to establish a dominant discourse and actors and networks, rather than building up common agreements. It is quite a challenge to develop *concertacion* processes under the threat of corruption and with corrupted actors.

The third constraint was time, as the investment of time needed for this kind of process is quite high, and goes far beyond a traditional PhD research process. Without the support of FORO, without the already mentioned research projects and the Municipality of Lima (during 2013/2014) and without the patience of my daughter having to deal with my prolonged absences, the main results of this research would not have been reached.

Chapter 2. Theoretical overview

In this thesis, I study the evolving relations and interactions between economic, social and natural environments within a metropolitan context. I focus particularly on how knowledge-building processes and water governance are configured within such environments in metropolitan cities. I start from a recognition that multi-level, multi-sectoral and multi-scalar territorialities structure the urban environment and that knowledge is socially constructed, informed by socio-political ideas, beliefs and discourses developed by actor networks in iterative processes. Such processes bring together risk perceptions, the power dynamics of governance networks, processes of *concertative* decision-making (or not), (including new insights from climate change scenarios), to assemble a complex configuration around metropolitan water governance that has no predetermined outcomes.

This analysis draws on three debates. First, there is the debate about a new concept of sustainability at a meta-level of this whole analysis, approaching development dimensions with a holistic vision where nature (particularly water) is recognised as another 'actor' exercising its power, and the territorialities at multiple scales in which water flows are embedded in what? (following the hydrological cycle). Second is the debate about understanding governance networks as configurations, where actors' discourses and coalitions and networks in inclusionary and iterative constructions of knowledge within *concertación* processes become visible, displaying the power dynamics in place. The third is the debate on risks, particularly those related to water and those attributed to climate change. There are several strands of current debates within the literature on water-related risks, disasters, and climate change: the social construction of disaster, disaster risk reduction, climate change scenario planning and lastly anticipation.

For this thesis, the case of metropolitan Lima in Peru countering the risks attributed to climate change through a scenario building methodology is used to contribute to a proposed multi-level climate-proof water metropolitan governance configuration for the unknown future to come.

2.1. The new concept of sustainability, global discourses, territorialities

2.1.1 The new concept of sustainability

The new concept of sustainability is 'understood from a constructivist perspective as long-term, multi-dimensional and multi-scalar process driven by socially negotiated and potentially contested or antagonistic visions, goals and values' which must be 'articulated with key political questions about who (or what) gains from practices and policies implemented under the label of "sustainability", who benefits from or are excluded from them, and what arrangements and strategies can be conducive to enhance the democratic content of decision-making linked to sustainability policies' (Peyroux et al., 2014:9).

This understanding recognises contextual differences, and it is closely connected to emerging South American concepts of sustainability such as '*Buen Vivir*', those coming from the Catholics with 'Laudato Si' Encyclical and those following a 'holistic' and more in-depth

ecologist approach within the sustainability concept. These new discourses analyse the ideas, discourses and practices around a way of life recognising the rights of natural systems and the needs of humans (Chavez et al., 2013)[27]. This development called '*Buen Vivir*'' (*Sumac Kawsay* in Quechua or *Suma Qamaña* in Aymara)[28] shows similarities to the conceptual frameworks of *Ubuntu* in South Africa and *lok Swaraj* or *parigraha* in India (McAfee, 2016). It describes a holistic 'new sustainability' conception by recognising the existence of every living being, considering them as both human and non-human actors (Gudynas, 2011). Figure 2.1 shows how the well-known traditional descriptions of all sustainable development dimensions can now include ecosystems and 'nature' as a separate category.

The recent ascendance of '*Buen Vivir*'' results from over two decades of 'alternatives to development thinking', which has included alternative sources of knowledges (Chavez et al., 2013; Cronicón, 2017; Escobar, 1984). The gist of '*buen vivir*' is that 'living well' or 'the good life' is only possible when communities are understood as encompassing both humans and nature. *Buen vivir* is thus well-being based on cohabitation of humans and nature, as in the Andean concept 'ayllu', where well-being encompasses humans, cattle, crops and the rest of nature. Nature should be understood as both its material and spiritual component (Gudynas, 2011). From this perspective, 'sustainable development' places human well-being as embedded in economic processes, which are embedded in social-political and cultural processes. So, economic processes embedded in cultural and social-political processes cannot become an overriding dominant force or interest. These dimensions are embedded and cannot exceed nature's limits.

Buen vivir offers an approach for discussions on alternatives to development, embraces a plurality of knowledges, conceptions and contexts, and has also become part of larger political projects. The new constitution of Bolivia (approved in 2009) and Ecuador (approved in 2008) incorporated the concept, the latter enshrining 'the right of nature'. In this research, this principle was considered by reflecting on the extent to which nature's right to water was considered by urban actors.

Such thinking is becoming more widely accepted. A recent example of a new sustainability concept emerging comes from the Pope's encyclical *'Laudato Si'*[29](Pope Francis, 2015), a global, multi-religious, multicultural invitation to adopt a holistic ecology that includes the poor and vulnerable and recognises that humans are part of the earth. Highlighting climate change as one issue that affects the earth, the encyclical calls for implementing a spiritual project built on a culture of care to achieve a new model of development and heal the relationship between humans and nature damaged by anthropocentrism (assuming a self-criticism of the bible saying 'nature should be controlled and exploited'). Moreover, Pope

[27] The central approach of '*buen vivir'* is that 'living well' or 'the good life' is possible when the community is understood as encompassing humans, nature and even spiritual life. '*Buen vivir'* is thus based on cohabitation of humans, nature and gods. Nature in turn should be understood as both its material and its spiritual component (Gudynas, 2011:44).

[28] Included in the new Constitutions of Ecuador (approved in 2008) and Bolivia (approved in 2009).

[29] Notably, Laudato Si places humans at the center of the solutions needed, arguing that human action and changes in our lifestyles that will lead us to a more sustainable path, and not technological models and approaches. Moreover, the encyclical calls for an intergenerational ethics and a communal project based on integral solutions that see natural and social systems (and crises) as closely connected and interdependent. This recognition, the encyclical argues, is key to achieve the spiritual and cultural changes needed to redefine what progress means and reimagine development models. Other religions – such as Islam, Hinduism and Buddhism – have already made statements with regards to climate change, recognising the need to preserve the Earth as a common good. Thus, Laudato Si is joining a wider and more diverse religious movement that aims to mobilise citizen concerns for nature and for climate action.

Francis' encyclical directly expresses support for civil society movements and international organisations pressuring governments to protect the environment, arguing that 'political will based on pressure by the population is required' (Pope Francis, 2015:179) and that society needs to 'pressure governments to develop more rigorous norms, procedures and controls' (ibid).

The existing South American social and political sciences research tradition is that development is done by 'somebody' and for 'somebody'; therefore, it goes from humans to institutions, as actors, with their values, capacities and power. This new research also acknowledges the existence of other species and natural resources with their own agency and power, becoming actors of development as well (Boelens et al., 2016; Maskrey, 1993). These holistic conceptions recognise nature's carrying capacity as a component of sustainable development (from '*Buen Vivir*' approaches), which requires minimising the use of non-renewable resources and/or promoting alternatives for and making rational and responsible use of renewable resources essential. This new concept considers nature as an equal actor with a voice, allowing it to 'participate' by recognising its ways of functioning and the inherent limits of ecosystems.

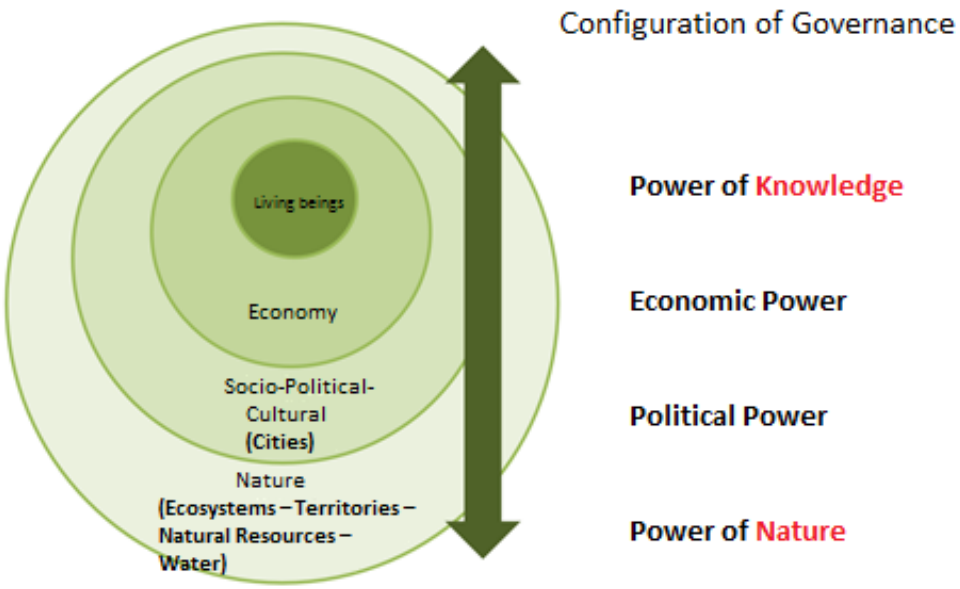
Incorporating nature as an actor, particularly water in hydrological systems, having agency and power changes the ways of exercising governance and management and fosters a new concept on sustainability. Nature on its own must be included and visualised (and not negated) as a variable in development, not just contemplated or seen as a resource for human development but all living beings. Ignoring nature in both short- and long-term analysis risks losing a complete understanding of risk and vulnerability, which generates conflicts, sickness, loss of life and infrastructure with recurring shocks. Neglecting the limits of nature and the environment usually leads to increased risk of disaster, facing different hazards (earthquake, flood, drought), the exhaustion of resources for any development process and increasing epidemic health risks.

This is a holistic vision, in which living beings are at the centre of questions of development. 'Living beings' are here understood as all beings, not only humans, as components of the planet. In Figure 2.1. this is expressed in successive layers of the dimensions of development (Haughton, 1997); the economy, the socio-political and cultural, and the environment, understood as territorial eco-systems (which involve *water*, air, flora, fauna, land and the subsoil), with water being the main concern in this research. Figure 2.1. below shows how development requires a productive economic foundation to start with; therefore the economic dimension is the first circle of this diagram. Likewise, development needs the establishment of social, cultural, institutional and political relations, which spread their activities in a specific territory and environment, and which simultaneously determine the boundaries of possible development trajectories. In this sense, there are four power dynamics in place: (a) power of knowledge, (b) economic power, (c) the socio-political power and (c) the power of nature and its environmental limits (Bombarolo, 1998)[30]. These dimensions are interrelated iteratively and dynamically according to the power which they use, apply to others or which is applied to them (Torfing et al., 2012). Involving power relations requires new forms of governance in hybrid networks or spaces of agreement (public, private, community and others).

[30] Based on Davidson, Forbes (IHS), UNI Conference, Lima, October 1999

The inseparability of the natural and social world is the key to various 'alternatives to development' approaches strongly promoted in Latin America. These alternatives have a few things in common: a profound criticism of (western) modernity and the dominant development model, the call for a locally rooted diversity (of knowledges, practices) and the call for a cultural and/or political re-appropriation of nature (Bakker, 2010; Boelens et al., 2016; Escobar, 1998; Gudynas, 2011; Swyngedouw, 2010).

Figure 2.1. A holistic view of new sustainability and power dynamics for governance configuration



Source: Adapted from Haughton, G. (1999)

For this research, I acknowledge the range of different actors, discourses and power, such as the power of knowledge, the socio-political and economic power, as well as the power of nature. I will at this stage only focus on the dynamics of the power of knowledge construction and the power of nature, particularly water. Further in this research, I will come back to the analysis of these types of power.

In the next section, I discuss the global debates on sustainability and development, focusing on how they deal with issues of water in a broad sense.

2.1.2 Global discourses on water linked to SD and SDG discussions

Global discourses on 'sustainable development' and water have evolved[31] and have discourses have been linked to discussions on cities and recently to risks attributed to climate change discourses. I have identified four discourses for each concept (see the section about water discourses below).

Initially, the sustainable development concept at global level dominated the national debates, where a predominant role of national governments with a combined focus on macro-economic growth and the conservation of nature and national resources would make their development model more sustainable. Cities or local governments were ignored. Although the Rio Declaration on Environment and Development of 1992 indicated the role of local governments, which includes promoting local Agenda 21 (Chapter 28), the emphasis was on transferring mandates but not resources (UN, 1992), which limited their work. After the Rio + 20 Conference, sustainable development was slowly but increasingly linked to cities, human settlements and housing (UN, 2012a; UNEP, 2012). The final document, 'The Future We Want', includes a chapter about 'sustainable cities and human settlements' recognising that cities that are well-planned, managed and constructed, and when functioning in an integrated manner, can promote sustainable *societies* economically, socially and environmentally. Similarly, the concept of a green economy was introduced when? (provide reference), but no consensus was reached, and the implementation was left open to each country, again, without major results.

Discourses on development, metropolitan cities, water and risks attributed to climate change

The development discourses can be clustered in several groups, in which the discourses of water, cities and risks attributed to climate change cluster together. This does not mean there are not cross-cutting issues, interdependencies and 'grey areas' between the discourses, and some actors may even use the language and main wording of one discourse, but in practice apply another discourse.

The interaction found in the literature between the discourses on 'development', 'city', 'water' and 'risks attributed to climate change' discourses are shown in Table 2.1, based on the assumption that in the territory and city, development discourses can be coupled with the development approaches identified as 'pro-growth', 'pro-poor', 'pro-green or *Buen vivir*' and the 'sectoral/pragmatic (mainly pro-large infrastructure investments)', being those generally associated with the public-private-partnerships (PPPs). The 'cities' discourses identified can be grouped as 'world-class' cities, 'global' cities, and the discourse which conceptualises the city as 'inclusive', 'popular' and 'equitable'.

[31] Discourse and narrative analysis is an approach that has gained increasing legitimacy over the last two decades and produced a strong body of literature to understand how societies are governed (see Hajer and Wagenaar (2003)).

Table 2-1 Discourses on development, cities, water and climate risks: their interactions

Development	**Pro-growth**	**Pro-poor**	**Pro-green or « *Buen vivir* »**	**Pro- (large) infrastructure**
Cities	Global/Competitive « World-class city»	Inclusive, equitable Social justice	Green/Sustainable Ecocities, Biocities Environmental justice	Smart/ Intelligent Efficient
Water	As an economic good A commodity	As a human right	As a living being's right	As a sector, mainly associated with large infrastructure options
Climate Risks	As inevitable 'natural' or denied Risk transfer mechanisms	As a chronic burden Risk normalisation Risk reproduction cycles ('Risk traps')	As a way nature 'participates' in the development process	Safer, stronger (re) constructions (which may reconstruct disaster), insurances

Source: Author

Finally, Table 2-1 shows the correlation with the water discourses, shown later, which define water as an 'economic good', as a 'human right', as the right of 'all living beings' or a socio-ecological good' and water as a 'sector'. The following sections set out the discursive arguments, statements and the discourse coalitions which support their hegemony.

These global discourses influence and drive major policy changes, particularly in southern countries and cities; they are agreed upon and spread mainly from the United Nations and world conferences, using international agreements and commitments. But these global discourses are usually fragmented and treated as separate bodies of knowledge by national sectors and/or disciplines. The most recent major attempt to interconnect and align such discourses, sectors and disciplines is the Sustainable Development Goals [32]. The SDGs reflect the progress made in thinking about how different dimensions of sustainable development can become better linked, be more connected. These goals are the responsibility of every country in the world, rather than only the Global South.

[32] United Nations Assembly, 'Transforming Our World: The 2030 Agenda for Sustainable Development' (visited 18.07.2016)
http://www.un.org/ga/search/view_doc.asp?symbol=A/70/L.1&Lang=S

Discourses on water: ***economic, social, socio-ecological and sectoral perspectives***

The modern discourses on water in the twentieth century have been dominated by those reflecting a utilitarian perspective, with a strong push for expanding large-scale water infrastructure for agricultural purposes, drinking water provision, and preventing water-related hazards from leading to disasters. This approach gradually developed the 'modern infrastructural ideal' for metropolitan water provision, implying a municipal or para-statal authority providing drinking water and sanitary services through piped networks. Since the 1980s, constructing dams as part of such infrastructure has become more and more contested because of their detrimental environmental and social consequences. Also, a strong international push for privatisation and increased cost recovery to replace inefficient public service providers was part and parcel of structural adjustment programmes imposed on many southern countries. From the 1990s onwards, the rights-based approach to development was given increasing attention, and 'water as a human right' gained importance. That these different approaches to water can be intertwined is evidenced by the Dublin principles[33], which define water as a *public good* (but not yet a right!) with an *economic value,* as a *finite resource.*

For this research, I distinguished four discursive approaches to water and its governance (see Table 2.1). These contribute to a better understanding of how discourses, rationales, major preoccupations and interests in urban contexts can be analysed. Identifying and understanding these approaches and underlying values can contribute to the management of conflicts, leading to agreements being reached for reconfiguring water governance, as well as for increasing urban actors' capacity to adapt to and address the plausible climate change effects expected in the near future.

Approaches about how water is governed and administrated are strongly influenced by how actors understand water[34]. In the scientific literature and among the involved actors in water governance, at least the following four nodal concepts can be outlined (Miranda Sara et al., 2011):

1. Economic: Water as an economic good or commodity (water for different users: generally mining or electric industry, households and agriculture) dominating the integrated approach of water resource management[35] with a 'linear' focus on the water use cycle (taking water from sources, using, recycling and disposing of it).
2. Social: Water as a human right and a social good (prioritising water and sanitation for domestic use), which can be complemented by other approaches (e.g. the integrated or socio-ecological approach).
3. Socio-ecological: Water as a socio-ecological good (water, drainage, ecological sanitation[36] or a hazard), incorporating the approach of water as human right of all living

[33] The Dublin Statement on Water and Sustainable Development http://www.wmo.int/pages/prog/hwrp/documents/english/icwedece.html visited 02.04.2017

[34] Or only seen as a resource in function from his point of view.

[35] The term water generally refers to the natural element, whereas the term 'hydrological resources' refers to water as an economic good, able to be used by anyone (Braga et al., 2006:1).

[36] The ecological sanitation is a non-conventional approach about the way of thinking and acting about human waste. It is an approach about the « closed cycle », both about zero-discharges, maintaining the sweet water bodies, and water free of pathogens and nutrients. First of all the ecological sanitation has an approach to ecosystems in which it considers valuable urine and faeces as necessary resources to restore the fertility of the soil and increase the production of food following this human rights approach. Residual water can be of great

organisms and right of ecosystems, and water as a hazard. Supporters of this discourse would emphasise that water (not only fresh water) is a non-renewable and vulnerable resource (and not open for economic compensation) and would argue for a holistic and profound ecological vision[37], observing the hydrological cycle (e.g. the metabolism of water).

4. Sector: Water as a sector, infrastructure (water and not always sanitation). It often goes in hand with an approach to water as an economic good and a renewable resource within a technological, pragmatic and infrastructural vision.

Dimensions of water discourses and analytical framework

Table 2.2 presents an updated version of an analytical framework (Miranda Sara et al., 2011) developed earlier with the characteristics of these discourses based on their target, main actors, main governance approach, key actors' participation and interaction strategy, and the territorial scale involved (river basin, city and/or neighbourhood scale).

Table 2-2 Water governance discourses and main arguments: An analytical framework

Water as:	Commodity Economic Good	Human Right, Social Good	Human and Ecosystems Right Socio-Ecological Good Water as hazard	Sector Infrastructure
Main concern	**Market-oriented**	**Human Beings**	**Human and other living beings**	**Sector, Mixed**
Target	Clients Providers Consumers	Users Communities Basic human need	Ecosystems based Water-related risk reduction	Rural areas, cities and towns Biodiversity
Main actors	Corporate Companies Governments Inter sectoral actors	Local and Sub-national Governments Communities	All beings (human and non-human), peasants, indigenous peoples and environmentalists Cross sectorial actors	Users and providers Water Sectors coordination Governments
Participation and strategies	Representative Authoritarian	Deliberative Democracy (DD)	DD including the voice of nature and minorities (e.g. peasants, indigenous) Nature and water participate on its own	Mainly representative Hierarchical

value for water and the quality of the soil, improving food security and contributing to the ecological transformation of the city (Based on Esrey et al., 2000).

[37] This includes the realisation in which water ecosystems have natural limits in which we need to stay.

			(meaning a disaster)	
Main governance approach	Elitist, Monopoly New Public Management (NPM)	Democratic Participative Mixed, competitive	Inclusive, 'concerted', interactive Network, Reflexive Mixed, competitive	New Public Management Corporate Social Responsibility Monopoly
Territory and City (scale)	The region, Inter River Basins, City, Neighbourhoods and households	City, Neighbourhoods and households	The region, Multiple basins Urban-rural-natural, Cities, towns and villages Coastal and marine areas	Basin, urban and rural Cities and towns

Based on: Miranda Sara et al. 2012; Follman, A. (2016); Pahl Wostl, C. (2015); Bakker, K. (2010); Boelens, R. et al. (2016).

The discourses identified here are used as part of the conceptual framework in Chapter 3 to analyse how various actors prioritise ideas on water governance and generate counter-discourses, the themes included and excluded - particularly those referring to climate change - , levels of hegemony of certain discourses and their temporality and the position of actors in relation to each other. They are used to identify the power relations and configurations which emerge based on these interactions. Thus, those who give major importance to any of these discourses are classified within one of the discourses, although in practice each actor – consciously or unconsciously – also used the words and language of the dominant discourses, even when they did not match with their focus. In the human rights discourse, for example, there are cases in which the vision of water as a commodity can also be found. In other cases, although to a lesser extent, the rights of other organisms are recognised. Therefore, this is not a 'closed' classification but a synergetic and dynamic one. As Hajer said, 'the political arguments of actors typically rest on more than one discourse at a time' (Hajer, 1995:43-45).

2.1.3 Hydrological cycles, territories and cities interactions: rescaling water flows analysis

The concept of territoriality is discussed here briefly, because water flows within the hydrological cycle across urban–rural-natural boundaries, with the water basin ecosystem as the most relevant territorial scale to be recognised when conceptualising water as a natural eco-system. Norman et al. (2014) already said, that 'the politics of scale can be understood as 1) scale is socially constructed, 2) scale is both fluid and fixed, and 3) scale is a relational concept', presenting scale as part of the complex dynamics in the interface between nature and society manifested in geographically different territories (Norman et al., 2014).

Within the different approaches to water, specific territorialities are recognised, and others ignored. Such *territorialities* are recognised and produced within actor network configurations, with their mandates and governance levels[38]. Particularly important are the

[38] Territorialities are defined as a 'controlled, bounded area, providing a means of reifying power' quoted in (Brethaut and Pflieger 2013), from Sack (1983). 'Territoriality is understood as delineating a governance arena

connections between urban, rural and natural areas linked through water basin ecosystems (Bréthaut et al., 2013). In the different approaches to water outlined above, the territorialities recognised differ, as do the boundaries of water systems in the analysis of the political regulations of water as a resource domain.

Both are manifest in certain territorialities, where water basin ecosystems are the typical unit of analysis, as demonstrated by Boelens and others in the concept of waterscape and hydrosocial territories (Boelens et al., 2016). The hydrosocial territories are intrinsically multi-scalar, with the need of the tri-dimensional view to understanding it, particularly when talking about water (ie: surface water, atmospheric rivers, underground water, oceans, humidity).

This research acknowledges quite diverse *territorialities* recognised (or not) and produced by the different actor networks, where the hydrological cycle brings water flow trajectories through river basins to metropolitan cities and human settlements, generally shaped by large and small water infrastructure. Where nature and society interaction has modified water cycles with infrastructure, some have provided impressive results in terms of water services provision, but others have negative impacts and do not yet anticipate sufficiently future disruptions from climate change effects. Urbanisation is also shaped by the geographic contexts within which cities evolve, including their embedding within water basin ecosystems.

2.2. Governance networks as configurations

The second debate on which this analysis draws on is configuring urban governance networks and interactive governance theory (Baud et al., 2015; Torfing et al., 2012). The discussions on governance networks are based on the recognition that (local) governments work with other actors in steering urban processes. Such governance processes are becoming interactive, drawing in a variety of actors, through multi-scalar relations, with more iterative processes, although power relations remain an integral issue in such networks. Particularly important are the basic services which governments provide, including water provision.

Other authors suggest that cities are put together through much messier processes and networks, bringing together ideas, material things, policies, networks, symbols and anything else, in processes 'assembling' the urban (McCann et al., 2012; McFarlane, 2011a). Urban assemblage theory assumes very fluid processes, with few barriers preventing knowledge, ideas, and objects from moving between people, and across various boundaries (local, national). It also assumes that knowledge about the city is learned, exchanged and appropriated, producing new combinations (McFarlane, 2011a). Critiques of the assumed fluidity of this approach indicate that barriers to knowledge exchange, policy mobility and networks exist in many cities, knowledge remains fragmented, and the difficulties in knowledge travelling across organisational boundaries limit the potential of governance networks (Baud et al., 2015).

Baud et al. (2015) have suggested an intermediate approach which recognises the possibilities of knowledge exchange through networks but also takes into account the organisational and

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for the political regulation of a resource domain, which is subject to rules and governance by one or more authorities.' (Bréthaut et al., 2013: 550).

legal barriers, which prevent such processes from becoming more fluid. This creates some stability, making it possible to distinguish *urban configurations*, with distinct discourses, actor coalitions, power relations, policy knowledge-building processes, territorialities and outcomes (Baud et al., 2015).

Such a framework creates ways of analyzing how different urban governance networks are assembled around water-related issues, within a 'process of becoming' approach (De Landa, 2006; McFarlane, 2011a).

2.2.1 Water Governance as networks

This research understands the assemblage of different networks as the recurrent interaction between a set of diverse actors, mobilised by their own interests (persons, institutions, public and private sector or alliances and/or associations of them), which develop discourses (see 2.1.1 and 2.1.2 above), establishing different relationships and related practices (Baud et al., 2014; McFarlane, 2011a). Those network assemblages can configure permanent coalitions, which exercise power relations with the aim to influence policy decision-making and budget allocations in their benefit. These coalitions are dynamic, but attempt to maintain stability by exercising dominance over policy decision-making processes. When referring to water issues, these networks act on multi-scalar hydro-social territories and multi-level institutions over time (Zwarteveen et al., 2014). Together, they produce the configuration of water governance networks and territorialities in practice.

As noted earlier, this research acknowledges different types of power (Figure 2.1). I am working mainly with two of them: the power of knowledge (see below 2.2.2) and the power of nature on its own (see 2.1.1. above), including water availability and water-related hazards[39], and the inseparability of nature and society relationships, where water appropriation, provision and distribution for human needs occur. Different ways of how power is exercised are also recognised: power over others, the power to cooperate with others and lastly the power of a particular form of governance (Torfing et al., 2012).

Having set out the view taken in this study of nature as an actor in its own right, the focus now narrows to apply such theoretical thinking on the new concept of sustainability to metropolitan water-related challenges, analyzing the interactions between those who produce different kinds of socio-ecological configurations for different people (Heynen et al., 2006). To unravel the configuration, it is necessary to include the whole trajectory of water flows, connecting traditionally divided urban-rural water (provision) and natural water systems (aquifers) within a multi-scalar territorial perspective on water eco-systems (De Sousa, 2018; Menegat et al., 2004; Sassen, 2009)[40] and examining how the relations and interactions about water produce 'hydro-social territories' (Boelens et al., 2016). In this approach, the urban water configuration combines different dimensions: the *discourses* on water (in relation to cities), the institutional *networks* involved, the *powerful* political struggles behind water appropriation, production and distribution, and the material and technical means by which

[39] The water related hazards in Lima, out of the climate change strategy approved by the MML, are heavy rain, floods, « huaycos » or mudslides, drought, heat waves, strong winds and epidemics.

[40] '…complex systems are multi-scalar as opposed to multilevel systems and the complexity resides precisely in the relation across the scales…the tension among scales is a feature of complex ecological systems a condition would certainly seem to hold for cities'. (Sassen, 2009: 49)

hydro-social territories are produced. Finally, the *outcomes* and their implications for sustainability in the longer term are addressed in this perspective.

As stated by many others, nature and society are closely interlinked (Bakker, 2010; Heynen et al., 2006). The political struggles behind discourses on water as a resource and its allocation, and the power relationships and inequalities within water governance networks are related to multiple scarcities, vulnerability and pollution (Escobar, 1998; Swyngedouw et al., 2003). Water-related ecosystems are losing in this interaction, suffering from the effects of modern society, in which industrialisation is showing its effects on nature and ecosystems through water pollution, water scarcity and water-related hazards, such as heavy rain peak events, desertification, sea-level rise, glacial melting, snowstorms and loss of biodiversity and species. These manifestations of how nature is changing are in turn affecting societies. Natural hazards related to climate change are expanding (IPCC, 2014b, 2019). Even if we have hidden, misperceived, deny or even naturalise or normalise hazards as attempts to diminish the strength of nature, nature keeps reminding us how powerful it is as an agent of change. So far on this planet, humankind, to survive on this planet, is recognising the need to *adapt* to new natural conditions and develop transformative capacities *to anticipate* the uncertain and *unknown* future.

2.2.2 Inclusionary processes (*concertación*) and iterative construction of knowledge

The specific question in this section is to what extent *concertación* processes exchange knowledge, build trust and enable joint planning (and how the ex- or inclusion of different types of knowledge contribute to them)?

This research departed from the premise that actors (being public, private, politicians, community, academic and others) or actor networks can use their knowledge and knowledge power to influence water governance structures, decisions and outcomes in their cities and territorialities. They can exercise democratic governance and effective participatory management under inclusionary (*concerted)* and transparent processes or, if not considered or after realising being misinformed or used, they can contest and even develop a confrontation process aiming to be heard. This is not a linear process- it is dynamic and depends on knowledge and power imbalances, relations and dynamics.

In this research, *concertación* processes are at the roots of the concept of governance, and they require competent, individual or institutional actors, whose independent participation, collaboration, and their willingness of mutual understanding and capacity, to build up agreements for socially supported decisions. Such processes may generate capacities to mobilise resources and provide a basis for implementation and action-taking. To *concertate*, actors need certain capacities. This implies a highly sensitive, complex and cyclical process of dialogue, negotiation, conflict management and consensus building, if possible (ideas mentioned by strategic interviewees Arnillas, Carrión, Diaz Palacios, Dammert, Arana, Alencastre)[41]. *Concertación* may evolve from clear confrontation to consensus and backwards depending on the moment of every socio-political process. These processes are usually a result of the support of political will thanks to active citizenship with civil society

[41] A separate excel file has been added with the list of interviewees, their backgrounds and positionality.

organisations and social movements pushing for their agendas and priorities to be included in the decision-making process.

In Peru, although the *concertación* approach is not the dominant approach in the highest levels of government, there is still an institutionalised culture of participation which has led to this more broadly used concept of *concertación* (Carrión et al., 2019; Dammert, 2003; Gaventa, 2009), based on equal relations between different social, economic and governmental actors[42]. *Concertación* processes in Peru, involving multiple actors at multiple levels, as well as at different geographical and territorial scales, have become mandatory in various contexts (Miranda Sara et al., 2011). As said before, following the new sustainability concept, it is also appropriate to consider nature as *another actor* with its own voice, allowing it to 'participate' through the recognition of its expectations, interests, needs and limits over those *concertative* processes. Incorporating nature as an actor is a different way of exercising governance and management that fosters a focus on sustainability.

In other words, it is important to involve different kinds of knowledge from multiple actors, such as i) tacit[43], ii) expert[44], iii) contextual[45] and iv) scientific knowledge[46] (Pfeffer, 2018; Pfeffer et al., 2013), while neither excluding nor making invisible, neither negating nor refuting any of them, not even knowledge of nature. Given that knowledge tends to stay where it was generated, searching for fluid forms of mobilising it and sharing it for a collective co-generation of knowledge regarding risk in metropolitan Lima, is one of the most strategic challenges.

This research uses the concept of iterative social construction of knowledge, particularly spatial knowledge, to comprehend the ways of how the socio-political power is being built and may be reconfigured. Addressing knowledge as power and how it is shaped by perception, interpretation and prioritisation requires a complex and systemic approach (Miranda Sara et al., 2016) where multi-actor participation and inclusion – as a socio-political process – can provide spaces for dealing with such a level of complexity, even with sometimes competing interests.

The relationship between water inequality, vulnerability and insecurity facing water-related climate change scenarios, paired with the prevailing centralised and fragmented Peruvian government that systematically excludes the vulnerable from decision-making processes to attend and solve their problems is what configures water governance networks.

2.3. Addressing water-related risks attributed to climate change through metropolitan knowledge building for the future

In the third theoretically relevant debate on which this research draws, there are four strands in the literature on water-related risks, disasters, and climate change: the social construction of

[42] '*Concertación*' has no direct translation in English. In this document, it is understood as a process of reaching agreements for joint action through dialogue and deliberation between multiple actors.
[43] Knowledge from experience, associated with people´s knowledge
[44] Knowledge from specialists, technicians and university staff, but also from those who know and practice their activity with expertise
[45] Knowledge related to locality, institutional and territorial context
[46] Knowledge published in indexed publications, proven according to scientific methods

disaster, disaster risk reduction, risks attributed to climate change and scenario planning and anticipation.

As said, actors have different discourses and perceptions, and they develop different power and knowledge interactions and dynamics on water-related vulnerabilities and risks related to climate change. Actors interact and *concertate* under certain governance configurations and territorialities following water flows. As these configurations concern future climate change, they incorporate another level of complexity, a temporal (historical and future-oriented) and not necessarily empirically based approach, including plausible unknown scenarios which require new capacities, such as the capacity to predict, to define trends, and in particular to anticipate the unknown.

To anticipate and be able to reduce risks and vulnerabilities attributed to climate change, a new and different approach is required in comparison to analyses of past events. They have to become projected as trends or projections towards the future or even to be built as futures scenarios for adapting, reducing risks, accepting losses and damages and/or enhancing opportunities.

The first strand, the social construction of disaster, is a concept well-developed in Latin American literature (Aragón-Durand, 2009). Given that disasters are socially constructed[47] (by the rich or the poor, by experts or non-experts[48]), all actors need to commit and get involved without ignoring, underestimating or making invisible social communities and their knowledge, as well as all actors' contributions, failures[49] and even misperceptions. Already in the 1980s, Peruvian and Colombian contributions from La Red, coordinating with international support, NGOs and academics (Blaikie et al., 1996; Fernández, 1996; Maskrey, 1993), focused attention on the concept of risk management and the realisation that disasters are not 'natural'--they are not part of the landscape, but a result of how humans construct physical infrastructure in the landscape. Current forms of urbanisation ignore natural processes; nature is not to blame for disasters, but rather how cities are built.

Going beyond the socio-ecological system approach to vulnerability, this political ecology perspective is firmly anchored in ideas on socio-natural relationships (Zwarteveen et al., 2014). The social construction of disaster in the Latin American context refers specifically to risks related to high levels of informality, 'laissez-faire' construction policies in parallel with a history of 'self-help' forms of urbanisation to combat housing deficits (Fernandez-Maldonado et al., 2010). High levels of migration and informal city expansion, having used those policies, means that migrants are disconnected from the historical environmental context, and as a result, disaster occurs when people are not [willing to be] aware of the dangers of particular locations[50]. This is well connected with a concept of chronic disasters or risk traps in which communities are exposed to invisible recurrent risks neither systematically

[47] A concept well-developed in the Latin American literature, mainly developed by La Red (*Red de Estudios Sociales en Prevención de Desastres en América Latina*) coordinating with international support, NGOs and academics (Maskrey, 1993).

[48] Which keeps happening not only as informal self-urbanisation but in all socio-economic levels, even and with the consent of government entities (legislative loopholes), creating a dangerous and gloomy model of cities, as shown in the case of Hyatt Hotel, which plans to build a 5 star hotel in the cliffs of Lima in Peru, see http://www.climasinriesgo.net/blogs/category-section/costa-verde/

[49] There is a long history of the denial of vulnerability, evasion or high levels of risk tolerance, unrelated to real facts (Baird, 1986).

[50] Although we focus on Latin America, similar risk patterns are found in other regions (e.g. van Voorst (2016); McFarlane and Desai (2015)).

tackled nor prioritised by social or urban policies, particularly those affecting poor areas (Allen et al., 2015).

Disaster risk reduction is the second strand of literature, based on these self-urbanisation processes and the development of proactive tools aimed at dealing with risks before disasters occur. This incorporates the necessity to prevent several risk phenomena simultaneously and to include the relationships and synergies between them in risk evaluations, as well as the decisive role of multiple government levels in prevention, response and reconstruction strategies. Nationally, disaster management is often the role of the civil defence ministries (Sperling et al., 2005), although in Peru, in practice such responsibility is delegated to local authorities with far less capacity and funding to deal with disasters (Cortez et al., 1998)[51]. Civil society organisations and communities are slowly being acknowledged and recognised as key actors in risk reduction strategies for successful implementation[52]. Globally, this is a more generalised and mainstreamed approach. For example, the UN Hyogo Framework (2005-2015), the UNISDR and Sendai Framework for Disaster Risk Reduction (2015/2030)[53] draws on these central ideas to generate the concepts of risk reduction and building resilience.

The third strand of literature is climate change management, evolving since the 2000s, which emphasises national and global agreements. This approach is epitomised by the IPCC (2014b, 2019), which presents a conceptual model of risk as the intersection between vulnerability, potential hazards and exposure to shocks and stresses, mediated by socioeconomic processes, climate, and large-scale biophysical changes, involving different scenario levels of greenhouse gas (GHG) emission and governance (Miranda Sara et al., 2016). This model combines inter-linkages, which produce risks with the potential to become disasters (Romero-Lankao et al., 2014). This approach is an evolution from previous conceptions, which focused on hazard plus vulnerability divided by adaptive capacity (Adger et al., 2007; Engle, 2011). Though when the recognition of social dimensions of adaptive capacity was seminal, the earlier formula did not recognise dynamic interrelations. This important contribution brings together two bodies of thought - disaster risk reduction and climate change management - in relation to risk reduction and climate change impact management.

Recent global reports point to the importance of both creating and using knowledge about vulnerabilities, climate adaptation and disaster risk reduction, and identifying and strengthening governance processes. It also stresses the importance of building resilience and enabling sustainable development supporting climate change adaption. The Sendai Conference (UNISDR, 2015) coming from a disaster risk reduction (DRR) perspective, also outlines the connections between understanding risks, governing them, preventing them by investing in resilience measures and 'building back better' when disasters have struck.

The fourth theoretical strand is anticipation theory[54]. 'Strictly speaking, an anticipatory system is one in which the present change of a state depends upon future circumstances,

[51] Cortez et al (1998) Manual Nr. 04 Cities for Life FORO

[52] As shown in www.climarecentre.org/minimumstandards and www.partnersforresilience.nl visited 06.12.2015

[53] http://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf visited 02/04.2017

[54] Miranda Sara and Dewald, Chapter 4, *World Disasters Report 2016*. "Anticipatory systems and proactive resilience-thinking need to make use of inclusive and innovative approaches such as scenario planning and action planning to enhance socially-supported resilience strategies and influence policy development and decision-making. Both these methods reinforce a people-centred approach that is at the heart of much resilience-thinking; scenario planning aims to build community capacity to prepare for – and even avoid – future shocks

rather than merely on the present or past' (Rosen, 1985, 2012). Anticipation is a new way of thinking about the future under climate change scenarios as there is a risk to presume that past experiences will inform adequate future actions. "Anticipation involves acting for the future in the present. Effective anticipation requires a shift away from the understanding that the future will be a repeat of the past. Climate change, urbanisation and population increases are causing new challenges to emerge which call for better anticipation. Resilience is concerned with the future, and therefore links actions before crises to the (hopefully improved) state following such events. Anticipation is, therefore, at the core of approaches to building resilience." (International Federations of the Red Cross and Red Crescent Societies, 2016, p 107).

Risk reduction theories and methodologies present their argument that future disasters can be forecasted and then to some extent prevented, which is no longer the case concerning risks attributed to climate change. Scenario planning for climate change intends to contribute to developing anticipation capacities for developing preventive actions for unknown futures, but those methodologies still need to be complemented with anticipation methodologies still being developed and tested.

Climate change is frequently associated with the idea that it only exacerbates the imbalances and inequalities that societies are already suffering, so there would be nothing new coming from it. This perspective, however, may paralyse and diminish actors' capacities to anticipate unknown futures which may come or even it could drive to (in)action, due to the refusal to accept the new normal emerging from those scenarios.

This new normal requires complex adaptive systems to anticipate, rather than only predict, future events based on past trends. Anticipation involves acting for the future in the present based on an actor's (human and non- human) ability to change such a plausible future (see Chapter 8). The alternatives developed are rooted in the knowledge present in the system about its plausible future states and to accurately assume each other's behaviour state. The perception of what the future should look like is usually driven by a westernised, modern worldview which does not necessarily coincide with a southern vision, realities and needs. This means that mental models and mindset operate under anticipatory exercises, and communities are more likely to anticipate their reaction to known hazardous events, than to unknown events. Literature accepts that the root causes of un-sustainability need to be tackled but the new challenges associated with climate change scenarios are yet to be even comprehended (IPCC, 2019).

In fact, on the one hand, the first two strands of literature concentrate on what has happened and use the knowledge and experience societies have about the past to predict future events and then to prepare, prevent and develop resilience capacities to overcome and diminish the plausible future consequences. On the other hand, climate change is uncertain, it cannot be forecast for sure, and trends may not continue. One needs to accept that what has happened before may not be the case again. So what is needed under climate change scenarios is to

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and stresses, while action planning relies on local capacity and knowledge (and, participatory budgeting concerns, among other things, to improve accountability of public finances through local scrutiny and engagement). Within each approach, the process of socially constructing knowledge, which implies incremental learning to create (and thereby rehearse) future scenarios, can strengthen social ties, trust and legitimacy among different actors – despite what may seem at first to be contradicting interests. Nonetheless, it is important to recognise limitations and potential risks, such as power and knowledge challenges, practical concerns with regards to political discontinuity, and a lack of budget allocation and time, which may affect the outcomes of such processes." (Miranda Sara et al., 2016: 102–132).

develop the capacity to anticipate 'unknown' plausible futures, to situations that may never have happened before. So, to continue using the same methodologies and techniques will not necessarily help for the scenarios to come. This may be the reason both epistemic communities, disaster risk reduction and even the social construction of disasters from the Latin American perspective are not yet well connected with discussions among the climate change scientific community.

Earlier research showed that knowledge is socially constructed by the interaction between different actors, social groups, such as communities, experts, governments and companies over time; spatialising such knowledge makes visible concentrations of risks and inequalities, and scenario-based maps on vulnerabilities indicate likely dynamics over time (Baud et al., 2014). Combining the focus on knowledge about water-related risks and the extent to which such knowledge is embedded in governance processes provides a better understanding of how and why knowledge building about potential disasters is not always sufficiently recognised and given priority (Miranda Sara et al., 2014a). For example, the difficulties for flood management knowledge to 'travel' across institutional boundaries have also been examined in Chennai, India (Jameson, 2014).

From the climate debate perspective, there is also a slow but clear shift from a global debate about carbon control to a more spatialised logic that attempts to develop carbon targets and quotas at urban and sub-regional levels. The Global Covenant of Mayors, the UCCRN, the Paris Agreement and the inclusion of an atlas and cities chapter into the sixth process of assessment report of IPCC are all defining a shift to sub-regions and cities in resilience thinking. But social learning also needs a more comprehensive knowledge building and reconfiguration of governance process which contributes to developing actors' capacities to anticipate and to adapt to future scenarios and to develop climate-proof metropolitan governance.

2.4. Global policy discourses on cities, water and risks attributed to climate change

Global policy discourses have focused on various aspects relating to cities, water and risks attributed to climate change, but have not always linked them together in ways, which could strengthen their approaches across these various topics. They also focus on variations of sustainability, sustainable development, and sustainable development goals (SDGs).

At the global level, UN Habitat focuses on integrating sustainable development and environmental challenges in the urban agenda originally set out by the Brundtland Commission (UN, 1987) by incorporating and connecting the Agenda 21 and the agreements of Rio de Janeiro (1992), the Rio + 10 conference (Johannesburg Summit on Sustainable Development, 2002) and the Rio + 20 conference (2012b) into its Habitat Agendas (Istanbul, 1996; New York, 2001 and Vancouver, 2006). It also includes the declarations of the World Urban Forums and Habitat III (from 2002 to 2016) with the New Urban Agenda (2017)[55]. Under the SDGs the 11th goal refers to sustainable, inclusive, resilient and secure cities, defining targets and indicators, which every city's actors and local governments should report about in 2030.

[55] Visited 18.06.2018 http://habitat3.org/wp-content/uploads/NUA-English.pdf

Regarding the global water discourses, the dominant discourse refers to integrated water resource management (IWRM) which considers water as a commodity and an economic good. Even several published reports consider access to water and sanitation as a human right. This right was ratified on 28 July 2010 as part of Resolution 64/292 by the General Assembly of the United Nations. The Millennium Development Goals set a target to reduce by half the number of persons without access to water and sanitation services by 2015 and the SDG 6th goal defines targets on water and sanitation as well for 2030. But although the water governance processes at the local level and water management institutions were not highlighted, the goals are a core focus in debates on water governance. In Peru, the constitution already incorporates the right to water as a human right, albeit as one of the economic rights (you may access water if you can pay for it).

The Paris Agreement (2015) of the United Nations Framework Convention on Climate Change (UNFCCC), promotes an integrated, cross-sectoral approach to the planning, management and sustainable construction of human settlements and cities, supporting local authorities, raising awareness among the population and increasing the participation of citizens, including the poorest, in decision-making processes. Under this whole process, water and risks concerns and interactions are slowly being developed.

In relation to risk reduction, the Sendai Framework from 2014[56] (before, the Hyogo Framework) was moving in parallel to the Paris Agreement (2015) process related to tackling global challenges around climate change[57]. Sadly, both scientific communities still find it difficult to build up connections, positive interactions and common understandings and methodologies (Helmer et al., 2006). Risks and vulnerability concepts and climate change discourses are still being treated separately at the national and local level. There are several targets in relation to risk reduction under the SDGs, particularly in the SDG 11, but there is a unique SDG on climate change, SDG 16. The process of interconnection and operationalisation has only recently begun.

But even after over 30 years of discussions and negotiations, civil society and scientists globally have reported that we are far from realising sustainable development. Social gaps, ecological problems, climate change challenges and urban inequalities are increasing globally and reaching dramatic levels.

Global discourses around cities have revolved in recent years (see Table 2.3), being the dominant one manifested on the discourse of the 'competitive city' within the context of the discourse of the 'global city'[58] (Sassen, 2009). This discourse builds on strategic instead of integrated planning and has moved from an urban, metropolitan or territorial scale of integrated city planning, towards a focus on 'megaprojects' where the unequal spatial distribution of investments exacerbates inequality, segregation and fragmentation (Jenks et al., 2000). Within this context, mega-projects are encouraged by the corporate sector, national governments and some municipal associations (Kennedy, 2015).

[56] Visited 18.06.2018 https://www.unisdr.org/files/43291_sendaiframeworkfordrren.pdf
[57] Visited 18.06.2018 https://unfccc.int/sites/default/files/english_paris_agreement.pdf
[58] Global cities allocate the global political power, housing company headquarters with all its symbolisms and urban icons trying to express their 'success' and on the other hand, newly industrialised mega cities in the South are hosting those companies' production sites, highly polluted. Both type of cities consume a high proportion of resources with a low index of recycling and therefore with a dangerous environment for human health as well as the one of the ecosystems expressing the increasing divide between rich and poor, particularly in poorer countries, as well as environmental damages without precedents.

The current discourses have evolved from the earlier push for privatisation as part of the new public management and decentralisation initiatives in the 1980s and 1990s. However, privatisation initiatives have weakened after several failures in the provision of public services (for instance water provision in Buenos Aires, Paris, Cochabamba), and nowadays the dominant operating modality is that of public-private partnerships (Kennedy, 2015). PPPs were first established to develop large-scale infrastructure projects and megaprojects, prioritising regenerative projects as 'urban enclaves' (for instance in Curitiba). Connecting these places with better equipment would improve the quality of urban living, and super roads and high-tech infrastructure would improve the quality and increase the competitiveness of specific locations (Kennedy, 2015). The core of this discourse can be found in the paradigm of growth ('modernisation and efficiency' as key words), which has been globally hegemonic and virtually indisputable despite the recurrent corruption scandals associated with them.

One of the core arguments of this discourse stresses an ever-increasing and permanently growing demand and hence, the consumption of natural resources (water, energy, soil/land, flora and fauna). More than half of the world population lives in urban areas and, by the mid-21st century this share is expected to grow to about two-thirds (UN-Habitat, 2016). Those demands may be expressed in the need of an endless increase in the number of houses (and associated construction resources). Ultimately, economic growth, which underpins the paradigm of growth, is seen to solve city challenges. Those defending this argument can thus connect the 'growth paradigm' with the need to increase investments in infrastructure. In most cases, the pro-infrastructural and pragmatic discourse goes hand in hand with the growth paradigm.

This growth paradigm is combined with the discourse of the 'compact city' implemented through city 'densification' (which usually means overcrowding city areas for the poorer). The 'compact city', often argued to have ecological benefits, can be used to direct investments towards zones with high construction rates but low population density. In Lima this discourse legitimised favouring investments in high-income areas (Miranda Sara et al., 2014), where a higher construction density was combined with more green area per person, resulting in a higher quality of urban life. In contrast, the low-income areas in the periphery exhibit low construction density, high population density and a low quality of life (Miranda Sara, 2015b). Hence, the 'compact city' has become a 'double' discourse when its implementation enhances city inequalities and fragmentation.

Researchers and global social movements have developed an alternative discourse to counter the paradigm of growth (Meadows, 1972; Schumacher, 1973) which has become a world movement of degrowth (Escobar, 2015; OECD, 2013), particularly aimed at the over-developed countries[59].

Poverty and environmental degradation are part of a vicious circle that leads to critical urban health and vulnerability problems (e.g. death from air pollution), which at the same time increases the vulnerability of the poorest people (UN-Habitat, 2016). Both the impoverishment and the environmental deterioration of cities are usually the consequence of prevailing centralised government that systematically excludes the poor from the decision-making processes directed at solving their problems. This has evolved into an accelerated degradation process of the urban quality of life, having a negative impact in the city. The poor urban areas reflect the result of a low rate of urban investment against a high rate of

[59] International Conferences on Economic Degrowth for Ecological Sustainability and Social Equity (since 2008 till now)

demographic growth. Governments could not establish re-distributive policies of the national or local surplus contributing to increase the differences of wealth. But it cannot be ignored that urban poor yet, due to their extreme needs, the low level of education and low self-esteem, are more reactive to political changes and have a short-term perspective focussing on what directly and immediately affects them. As was shown by Miranda Sara et al. 2017, other environmental improvements become their priorities only when the diseases, death or loss of means of subsistence, which are caused by environmental factors, become evident.

Climate change and desertification being long-term problems are hardly a priority for the poor unless they suffer and see direct and clear effects, as they did after the El Niño 2017. Actors and urban poor in particular may even accuse youth and environmental activists of being 'against' development.

The green city, bio-cities, eco-city discourses consider the limits of nature and promote the closure of the cycles of resources being used by them. Reduction, recycling and reuse of any resource are their main concerns. The cities for life, eco-adapted and even resilient cities discourses are introducing the capacity to adapt to climate change effects into their main concerns (Pahl-Wostl, 2015). Cities' management and investments with a sustainability approach remain a key challenge to change actual trends. Under a new sustainability concept as a starting point, city development attempts to satisfy the needs of their inhabitants, particularly the poorest and most vulnerable, and at the same time support the development of the surrounding rural areas and natural ecosystems, on which cities depend for their existence without generating negative impacts or reducing and compensating them. Such concepts have been the basis for the Cities for Life Forum (FORO) in Lima, whose name expresses the basic goal towards which it strives.

Smart city and intelligent city discourses are associated with the efficiency and manageable city discourse, focused on technology to solve the main city development challenges, promoting universal access to services and transport and even reducing greenhouse gas emissions (GHG). Yet, even as those proposals are being promoted, they remain weak and dispersed in terms of investments and development (Verrest et al., 2019).

This chapter discussed how these discourses influence and interconnect within an actor network governance configuration and how relevant a spatial analysis is, following the flows of water within a hydrological cycle and territorialities in practice. These approaches help understand the level of inequalities and vulnerabilities within metropolitan cities such as Lima. It can already be stated that this analysis needs a multi-institutional, multi-sectoral, multi-scalar geographical perspective and a multi-temporal analytical framework with a multi-actor involvement. This approach may contribute to the social construction of knowledge to build up agreements, with the assumption this will contribute to a climate-proof water governance reconfiguration.

My main research question was: How are Lima´s water governance networks being reconfigured in terms of discourses, network coalitions, territorialities of practice, and inclusionary knowledge-building processes to confront water-related risks, vulnerabilities and inequalities associated with climate change?

Chapter 3. Research questions, conceptual framework and methodologies

This chapter elaborates upon the research questions, conceptual frameworks, research approaches, and methodologies used in this research. It sets out the rationale for the research approach taken, which combines analysis through several research projects and the main policy products developed as a result (and part of the overall approach), as well as setting out the methodological considerations. I start with a short reflection on my position as a researcher and mobiliser.

This investigation employed a participatory and *concertación* (understood as building up socially supported agreements, decisions and taking actions) action-research approach with multiple actors' involvement, including their networks and coalitions, in metropolitan Lima, Peru. The empirical research has built on both my academic research experience as well as on my work with an existing network organisation FORO (Cities for Life Forum). The FORO brings together multiple actors (municipalities, universities, NGOs) from 20 cities of Peru, striving to improve cities so that they become 'cities for life'. I have been a member and the executive director of the FORO (since 1996 and 2002, respectively), working together with the FORO team and members, mainly professional and environmental women leaders from 20 Peruvian cities. The raison d'être of the FORO network is the social construction of knowledge and capacity building for urban environmental management so that FORO could draw on an extensive existing network of actors in Lima and Peru.

I applied a problem-solving focus as well as a process-oriented action-research. As a result, this research started in 2010 and, for the purpose of this dissertation, ended in 2018 (with a break between 2016/2017). During that period several actors from different organisations, diverse institutional levels, sectors, disciplines and geographical scales were invited and participated in different ways, meanwhile developing capacities to anticipate long and very long-term scenarios (and visions). I also engaged in and used dialogues and debates with the public on social media such as Facebook and Twitter[60], as part of a wider process of the social construction of knowledge. In a way, it is still difficult for me to say this is *my* research because it is so much *our* research, '*our'* meaning a wide spectrum of actors involved. Although I have been the actual researcher and I am the only one responsible for the final results of this dissertation, it is also a FORO research with the contributions of many actors and I want to acknowledge that here.

The choice for researching metropolitan Lima is linked both to the city on which I have the most knowledge, but also due to its particular situation as the capital of a highly centralistic country and its great influence on national politics. Lima is one of the cities in the world with the lowest rainfall, surrounded by a desert and highly vulnerable to climate change impacts like drought and flooding. Around 58% of the Peruvian urban population lives in the metropolitan area; almost 10 million inhabitants (INEI, 2017), and it is the main economic hub of the country. Lima is on the west coast of South America, which experiences strong influences from the El Nino phenomenon. It lies at the conjunction of three major river basins, yet it requires large scale infrastructure to bring water from the other side of the Andes.

[60] I regularly published, although not systematically, short statements, opinions and comments as well as followed dialogues with those reacting (I have 5000 'friends'.)

Lima was also chosen because it was there that I used the support of and interaction with two ongoing, complementary FORO research projects in which I participated as a member: LiWA and Chance2Sustain. Later on, I was involved in the development of the Lima Climate Change Strategy, which was approved in 2014. This was possible due to a politically favourable climate with a committed Lima Municipality, and a strong mayor (2010-2014). In the case of LiWA, we applied a quantitative and qualitative scenario building process, and in Chance2Sustain participatory action research, while in the climate change strategy a *concertacion* process was used for its design. In these three processes, I had different roles. I was a co-investigator in LiWA, co-leader of the Work Package on Water Management with specific responsibility for Lima in the Chance2Sustain programme and director of the technical team developing the climate change strategy of Lima. So, since the beginning, I combined roles, as a researcher and academic, as a woman environmentalist and activist mobilising change in the cities of Peru, starting particularly in Lima. The analysis was dynamic and process-oriented because it was developed during the ongoing decision-making processes, with real metropolitan actors interacting.

Also, in terms of governance, Peru is a relevant case because it combines strong central government and privatisation initiatives (Ioris, 2012, 2013) with various forms of participatory and *concertación* processes that provide residents with some degree of influence. Besides those aforementioned research projects, I participated and contributed to decision-making processes not only in Lima policy products development, as I will explain, but also in Peru as a whole. So, this research benefitted both from the existing culture of *concertación* in Peru and the favourable political environment at the Lima Municipality (until 2014) and later on from my role as Principal Advisor in the Environmental Commission at the Congress of Peru (mid-2016 to 2017), which coincided with the disaster that occurred after El Niño Costero in 2017. This Congress Commission was headed by the former president of the Cities for Life FORO, whom himself became a congress member, and with whom we were dealing while writing and negotiating the Climate Change Framework Law of Peru, Law N° 30754, which was unanimously approved by the Congress in 2018 (after the El Niño Costero disaster hit the country and Lima, as shown in the Introduction).

All these conditions brought actors together to debate issues and agree on solutions to develop proposals for action, which led to the approval of the Climate Change Framework Law of Peru. Therefore, Peru and metropolitan Lima constitute a relevant case for a detailed study on water governance in a time of climate change.

The different processes in which I was involved were not linear. Being the director of the FORO team, we contributed to the development of the climate change strategy of Lima with the technical group of the Environmental Commission of the Lima Metropolitan Municipality (work sponsored by Avina) during 2013 and 2014. This climate change strategy was a result of a city debate, consultation and *concertación*, and formally approved by the municipality at the end of 2014. However, the following mayor, (in position from 2015 to 2018) was a climate change denier, his administration did not implement the strategy, at high expense to the city after the El Niño Costero in 2017 (see Table I in the Prologue) had hit the city. So during 2018, only eight district municipalities of Lima have started to design adaptation measures applying the new law (with FORO support and sponsored by GIZ).

The processes in Lima in which I have been involved (LiWA, Chance2Sustain and the climate change strategy) contributed to what I call a process of social knowledge building which drives the *concertación* of policy products and processes in Lima and Peru. Those processes also led to existing networks linked to the FORO being extended to other actors in policy

networks, where the trust and mutual confidence is being built up. This action-research approach is generating new opportunities to utilise and contribute my expert knowledge regarding emerging climate change issues. Those interactions within an iterative and interactive research process helped me trace patterns of discourses and core arguments to understand how networks of actors are constructed, how they are based on policy knowledge and power building processes and finally how decision-making is led and enacted in the territory at multiple geographical spaces and scales. Thanks to this spatial perspective, social and spatial water inequalities were made visible.

So, the main purpose was (and remains) to discover means and strategies which can drive new multilevel climate-proof metropolitan water governance configurations. More broadly, for achieving that, I aimed to find out how to reconcile and to 'concertate' without losing principles under the tensions of very different approaches and understandings of the current water situation and uncertain futures in Lima, which may generate climate-proof water governance changes in metropolitan cities configuration in other metropolitan cities.

3.1. Research questions

The main question of this research is:

How are Lima´s water governance networks being reconfigured in terms of discourses, coalitions, territorialities of practice, and (inclusionary) knowledge building processes to face water-related risks, vulnerabilities and inequalities associated with climate change?

The main research question has been split up into more specific research questions which each contribute to understanding how the configuration of water governance is built up dynamically, looking specifically at the discourses which dominate the policy decisions, the main actor networks, territorialities involved or excluded and how knowledge building processes influence inclusionary processes through which water governance is carried out. Specifically, this study focuses on (1) processes of iterative knowledge building, (2) the extent to which it includes different types of knowledge, (3) being inclusionary in terms of participating actors, and (4) how these processes influence policy decisions. The main processes of knowledge building included are those around scenario-building about inequalities, future risks and vulnerabilities around water-related issues in Lima.

Specific research questions were the following:

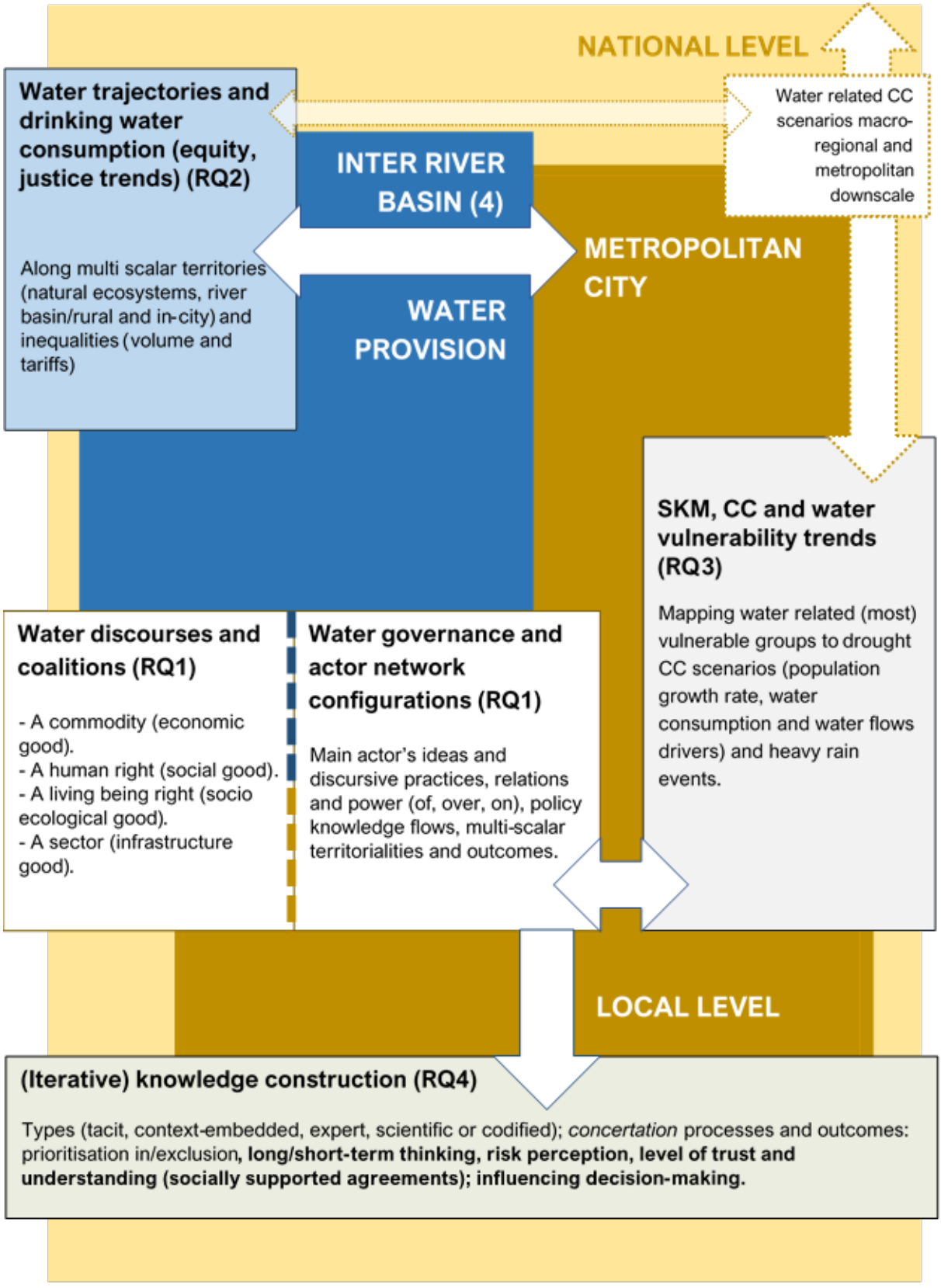
1. How are the Lima water governance networks configured, in terms of main actors, discourses and practices, power relations, policy knowledge flows, territorialities and outcomes?
2. How do mapping processes built up through iterative knowledge construction in *concertación* processes in Lima reveal uneven geographies of water-related (climate change) risks, vulnerabilities and inequalities in cities (and territories)?
3. To what extent do *concertación* processes exchange knowledge and build trust and joint planning--and how does the (ex)inclusion of different types of knowledge contribute to them?
4. How do knowledge construction and risk perceptions of water-related disaster risks and vulnerabilities affect decision-making and implementation in urban governance networks? (and what are possible reasons behind high levels of risk

tolerance and the lack of decision-making initiatives in putting adaptation and/or preventive measures in place?).

3.2. Conceptual framework

The conceptual framework applied during this research is shown below in Figure 3.1, outlining the four specific research questions of the study. This figure shows the main concepts and four specific questions incorporated. A short conceptualisation and methodology of data collection are provided for the reader. Figure 3.1 also shows how the four specific questions derive from the main research question and how they are interconnected.

Figure 3.1 Conceptual scheme



3.3. Specific research questions

3.3.1 Water Governance Configurations: Discursive practices, coalitions, relations and power

The first specific research question concerns how Lima water governance networks are configured, in terms of main actors and their networks, discourses and practices, power relations, policy knowledge flows, and territorialities of practice.

This question focuses on several dimensions. The first concerns the water governance networks and their configurations, while the second concerns the main discourses within various networks, indicating their ideas, understandings, beliefs and values regarding water issues. The third concerns the actor networks and coalitions formed, their unequal power relations and discursive practices. This includes inclusion and exclusion of actors, and how they influence policy processes. The fourth concerns policy knowledge flows within and between networks. Particularly important is which water issues and knowledges they consider (inequalities in provision and distribution, water regulation and implications of water-related climate change scenarios) (McFarlane, 2011b; Miranda Sara et al., 2014). The fifth dimension concerns the territorialities of practices, linked to socially constructed governance arenas for politically regulating water as a resource domain. Their institutional and territorial boundaries can reproduce or change inequalities at multiple scale and levels, with uncertain future plausible scenarios resulting from those dynamics (Miranda Sara et al., 2017).

Water governance configurations

The high level of fragmentation and sectoralisation of the water management in the country and metropolitan Lima in particular evidence the need to connect or at least show the connections between the different institutional levels and sectors to understand the water governance configuration in metropolitan Lima. As shown in the conceptual framework figure (Figure 3.1.), the thesis examines water governance processes in Lima by using a territorial perspective at multiple geographical scales (macro-region, river basin, metropolis, neighbourhood and water sectors), analyzing multi-level government processes (national, regional, metropolitan and local), as well as the role of the multiple actors (public, private, political, civil society, academics, communities), engaging in water governance with a multi-temporal (present to the future: historical) perspective.

Water vulnerability perceptions of the residents and key actors, actor networks and discourse coalitions have been understood by applying the concept of ‘configuration’ as developed in the Chance2Sustain project and laid down in the analytical framework paper (Baud et al., 2014).

Discourses

To build up an understanding and disentangle the different actors’ interventions during interviews, scenario workshops, dialogues and negotiations, the discourses used by actors were analysed. According to Hall, discourse for Foucault means ‘...a group of statements which provide a language for talking about - a way of representing the knowledge about - a particular topic at a particular historical moment...Discourse is about the production of knowledge through language’ (Hall et al., 1992:201). Discourse is also defined as ‘an ensemble of ideas, concepts, and categories through which meaning is given to phenomena. Discourses frame certain problems: they distinguish some aspects of a situation rather than others’ (Hajer, 1995:43-45). Hajer states ‘a discourse coalition is thus the ensemble of a set of

storylines, the actors that utter these storylines, and the practices that conform to these story lines, all organised around a discourse' (Hajer, 1995:43-45). I agree that 'discourses through which policies, associated texts and rhetorics are articulated, means much more than language'. Therefore, following Atkinson, particular emphasis has also been given to a 'second generation' of discourse analysis methodologies that, in part, also includes a focus on power (Atkinson et al., 2011:119): '…from this position power and discourse cannot be separated as discourse is shaped by power and power shapes discourse'.

Furthermore, Hajer´s (1995) criteria have been used to determine whether a discourse dominates:

(1) if it dominates the discursive space; that is, central actors are persuaded by or forced to accept the rhetorical power of a new discourse (condition of discourse structuration); and

(2) if it is reflected in the institutional practices of that political domain; that is, the actual policy process is conducted according to the ideas of a discourse (condition of discourse institutionalisation).

Coalitions and power relations

For the second dimension, I link water discourses to the concept of urban configuration as an analytical lens (Baud et al., 2014; Jordhus-Lier et al., 2019; Sutherland et al., 2015), which captures the important elements of the governance of water-related vulnerabilities, risks and inequalities. It distinguishes not only the dominant discourses and framings around water and water-related issues, but also the actors and coalitions involved, the processes and methodologies of producing spatial knowledge on water-related issues, the materialities and spatial scales at which issues are dealt with, data inputs and classifications, and the outcomes regarding practices (Miranda Sara et al., 2016).

The dynamics of these configurations are driven by discursive coalitions and by dominant and counter-discourses, which create, expand or weaken the legitimacy and ability of coalitions to influence nodal concepts and arguments, and which may be incorporated into policy development and decision-making (Hajer, 1995). Hajer points out that 'in analyzing political discourse, attention must be paid to power relations, institutions and domination' (Hajer, 2005: 305).

Following on, Hajer (Hajer, 2006: 71) states that the discourse coalition approach has three advantages:

(1) It analyses strategic action in the context of specific socio-historical discourses and institutional practices and provides the conceptual tools to analyse controversies over individual issues in their wider political context.

(2) It takes the explanation beyond mere reference to interests, analyzing how interests are played out in the context of specific discourses and organisational practices; and

(3) It illuminates how different actors and organisational practices help to reproduce or fight a bias without orchestrating or coordinating their actions or without sharing deep values.

To identify and analyse the relations among discourse coalitions' 'representatives' or 'champions', I have identified the institutional and organisational practices and strategic

actions within the wider political context of metropolitan city water governance[61]. They could be individuals, institutions and/or socio-environmental networks. The ways they interact, coordinate (or not), include or exclude certain actors and build up their relationships in the water governance arena, are called here an 'actor network configuration'. These configurations are usually the means for discourse dissemination and legitimisation for policy design and its further implementation.

3.3.2 Iterative knowledge construction and uneven geographies of water-related vulnerabilities and inequalities

The second key research question concerns how mapping processes built up through iterative knowledge construction in *concertacion* processes in Lima reveal uneven geographies of water-related (climate change) vulnerabilities and inequalities in cities (and territories)[62].

In the debate on urban climate change adaptation, 'adaptive management' is increasingly utilised (Pelling, 2011). Social and organisational learning is essential for system survival, and both planned actions and responses to unexpected shocks are necessary. Building up the knowledge involves learning from experience, adding to codified knowledge and proposing future actions. A major assumption is that participation by key actors is necessary for building consensual agreements, reducing conflicts and opening up new sources of knowledge (Healey, 2007; van Buuren, 2009).

In Peru, *concertación* processes involving a variety of actors have become mandatory in various contexts (Miranda Sara et al., 2011). Key characteristics are learning-by-doing, combined with constructing knowledge through various social networks. The latter implies the validation (or contestation) of the knowledge of a variety of participating actors, and an extremely sensitive and complex process of dialogue–negotiation–*concertación*–conflict management and consensus-building (or not). Such processes can be seen as constantly evolving cycles (Pfeffer et al., 2013; van Buuren, 2009).

However, there are also concerns about factors influencing the extent to which different sources of knowledge are included in metropolitan water governance decision-making. These concerns take two broad forms: one involving the power relations in new forms of hybrid network governance; and the other, ways of 'mapping' and unravelling embedded knowledge from local communities as counterpoints to expert-led, organisational knowledge (Karpouzoglou et al., 2012). Both attempts to integrate 'lived experiences' from practice with planning proposals and their spatial representations for urban adaptation and development strategies. However, the discourses, actors and experiences they acknowledge are quite different. In hybrid network governance, the debate is framed around knowledge management, as metropolitan municipalities attempt to combine economic growth measures with better service delivery, increasing adaptive capacity and the transition to sustainability in their use of natural resources, water being a strategic example (Hordijk et al., 2014). These discussions usually concentrate on the inputs of codified or expert knowledge in professional organisations. However, the knowledge of a much greater variety of actors needs to be

[61] This format was developed with others in the Chance2Sustain project (Miranda et al. Fieldwork Report WP4).
[62] I refere here to my own work Miranda Sara, L., & Baud, I. (2014). Knowledge-building in adaptation management: concertación processes in transforming Lima water and climate change governance. Environment and Urbanization, 26(2), 505-524

included in designing and implementing urban resilience strategies, including that of embedded in professional practice (e.g. engineering, community work), the lived experience and strategies of local communities and the lay science built up through community-based research. Mapping such embedded knowledge means including community-based actors and their representatives (Jordhus-Lier et al., 2019; Scott et al., 2009).

Decision-making for a metropolitan city, neighbourhood resilience and transition strategies also implies including multi-scalar territorial approaches and perspectives (local, regional, inter-basin, macro-regional)[63]. Framing water risk issues and designing and locating water provision and disaster prevention systems requires tracing and planning processes across space and time. Although various mapping techniques are becoming more common for spatialising knowledge, there is still a large divide between planners and engineers on the one hand and the wider community on the other, less familiar with such instruments as GIS (Pfeffer et al., 2015). Similarly, the sources of information and the dimensions included need to be made explicit to determine whether the priorities of all actors are reflected and whether relevant information and communities are (ex)included (Martinez et al., 2011; McCall et al., 2012).

Therefore, in defining knowledge building and knowledge management in water governance configurations generally, we include these dimensions: the framing of issues and analysis of perspectives; the variety of actors producing and using knowledge in network governance (and who is excluded); the coalitions and networks formed, including their power relations, processes of cooperation and contestation; the spatialised knowledge produced; and the changes in processes and outcomes that result from using hybrid sources of knowledge.

3.3.3 Concertación processes: exchanging knowledge, building trust and joint planning?

The third key research question concerns the extent to which *concertación* processes exchange knowledge, build trust and undertake joint planning and how the (ex)inclusion of different types of knowledge contribute to them. This takes the analysis into a specific context – that of the *concertación* processes, in which the knowledge of various actors is included in the discussions on what activities should be undertaken in urban planning and management. Building up the knowledge – organisational and social learning – involves cycles of learning from experience, adding to building up codified knowledge, and proposing actions for the future. A major assumption is that strong key actor participation is necessary for building consensual agreements, reducing conflicts, and opening up sources of knowledge not otherwise available. Such processes can be seen as cycles, which are never static, constantly evolving. Scenario building is a specific form of such inclusionary processes, which is increasingly done in various contexts, to analyse future uncertainties and current complexities in issues which cut across several sectors.

Several *concertación* processes found in Lima were analysed as cases in point; those of scenario building on plausible future water-related climate change scenarios in the LiWA project, those through iterative workshops with local networks in the Chance2Sustain project, and the Climate Adaptation Committee for the city of Lima. Major research activities about

[63] A city in itself cannot be resilient, but needs to include watershed levels, and underground water systems to be complete.

Lima's water governance was the scenario building process by the LiWA research project[64] from 2008 (Schütze et al., 2019), and the spatial knowledge development through the Chance2Sustain (C2S) research project[65]. In these processes, the spatial relations between exposure, inequality and multiple vulnerabilities – exacerbated by extreme climatic conditions – were explored. In the first process, the analysis of stressors already happening, eroding, altering or strengthening the water system and its capacities on an ongoing basis were considered. Participants contributed to workshops, focus groups and interviews, and through these, the effects were systematised and driving forces identified to build scenarios in Lima to 2025 and 2040[66].

One of the main assumptions is that the participation of multiple actors is necessary for iterative and interactive processes of coming to agreements, which reduce conflicts and open spaces to include new sources of knowledge. In order to do this, the negotiation processes permit (or negate, refute and exclude) the validation of the variety of participating actors' knowledge, establishing very delicate and complex processes of dialogue-negotiation-agreement-conflict management to achieve viable pacts, contributing to the creation of consensuses (or not).

The C2S research project provided a useful context for further developing the qualitative scenario analysis for the PhD. The C2S project studied how spatial knowledge management changed urban planning and management processes in economic growth, dealing with social inequalities, and water-related risk management. The PhD research linked to the project by analyzing the spatial implications of the scenarios developed earlier in Lima. As work package leader for the water-related risk management theme, I also developed many of my ideas in a comparative setting across six other cities in BRICS countries, thus validating my research results from a comparative perspective (Miranda Sara et al., 2014).

3.3.4 Knowledge construction, risk perception, decision-making and implementation

The fourth key research question concerns how knowledge construction and risk perceptions of water-related disaster risks and vulnerabilities affect decision-making and implementation in urban governance networks[67]. It analyses reasons behind high levels of risk tolerance and the lack of decision-making initiatives in putting adaptation and/or preventive measures in place. The social construction of knowledge approach, as an inclusionary process, combined multiple sources of knowledge through fieldwork, focus groups, workshops and consultation processes regarding spatial distribution developing present and plausible future water inequality in relation to population growth and climate change scenarios which contributed to the metropolitan climate change strategy development and approval.

[64] www.lima-water.de (visited 12.06.2018)
[65] www.Chance2Sustain.eu (visited 12.06.2018)
[66] Twelve main water-related forces driving change in the water sector were agreed upon: form of government; water company management; water tariffs; population growth; urban poverty; water consumption; catchment management; urban form; water deficit; wastewater treatment and re-use; water infrastructure; and climate change (this last one as explained in the text above), (Miranda Sara and Baud, 2014).
[67] This section draws heavily on chapter 7 published earlier as Miranda Sara, L., Jameson, S., Pfeffer, K., & Baud, I. (2016). Risk perception: The social construction of spatial knowledge around climate change-related scenarios in Lima. Habitat International, 54, 136–149.

The research question analyses two case studies in which spatial knowledge was built around water-related climate change risk scenarios, which either already are or can become disasters (scenario building). The first concerns the long-term possibility of water scarcity and droughts, the second immediate extreme weather events that manifest themselves as floods and El Nino effects. To answer this research question, the first case study investigated the issue at the metropolitan Lima scale, and the second investigated it at the scale of a vulnerable community in eastern Lima. Both cases illustrate iterative spatial knowledge construction, in which processes of risk prioritisation, normalisation and tolerance occur, and the resulting (in)action by a variety of actors.

The first case describes an interactive research project in Lima on long-term stresses related to plausible climate change scenarios, and the extent to which participatory knowledge building processes led to changes in the mindsets and decision-making of the policymakers involved. Here, I was involved, as the team leader of the Adaptation Strategy for Lima encompassing an iterative scenario building process, analysing materials produced during the process, and interviewing other metropolitan actors and researchers (see Section 3.4). The second case concerns a short-term heavy rain event scenario, where a poor and informal local community in Chosica, in the East of Metropolitan Lima, has suffered repeated flooding and disastrous mudslides in 1987, 2002, 2012 and 2014, culminating in the March 2015 disaster (cf Table foreword). The Chosica affected settlements are mainly the result of 20 years self-constructed informal settlements in highly risky dry ravines. Despite government warnings not to settle there, following a 'laissez-faire' urban policy, residents have received land titles, utilities and social services and are refusing to be relocated. Here, with my coauthors, I collected and analysed expert/professional and official maps over time on settlements in Chosica outlining the urbanisation of risks, and how the informal settlements have been formalised. I also conducted short interviews with community members, functionaries and experts, and reviewed TV and newspaper reports.

This research methodology for the fourth specific question will help to identify that spatial planning is a quite political process, in which knowledge is contested or even when acknowledged, does not necessarily steer decision-making processes, either by local communities, authorities and private institutions (Baud et al., 2015). Besides, I identify existing models linking knowledge construction to risk framing, risk tolerance and how these influence decision-making processes and actions to prevent disaster may ignore risk tolerance, through normalisation and prioritisation at their peril.

3.4. Research design and data collection

In this section, the choices made in the research design, methodologies and data collection are discussed. It includes the research approach developed, the main experience and knowledge I draw on, the choice of location and geographic scales, and the specific methods of data collection.

As said, this research has been informed by my more than thirty years of hands-on experience as the leader of the FORO, as a consultant to various government and municipal institutions, as a researcher in diverse research projects and as an active participant in national and international forums concerning climate change, habitat and urban resilience as well as sustainable development. This led me to employ a participatory and *concertación* action-research approach, combined with fieldwork (strategic interviews, web pages search, focus

groups discussions, workshops and seminars for a wider audience) and others (cf data techniques) over five years, while working in various capacities on climate change adaptation and water governance issues in Lima and Peru (see 3.4.2.). More specifically, my previous experience in working with existing water governance networks in Lima, Peru, and internationally, provided me with personal and institutional legitimacy, gave me access to strategic actors in the water governance configuration of metropolitan Lima developing an iterative and interactive process of knowledge flow and socially constructed knowledge for *concertacion*. This allowed me to map the networks among different actors, their discourses and power relations.

3.4.1 Methodological choices and data collection

The methodologies varied according to the analytical lenses used: 1) water governance configurations, 2) processes of participatory and inclusive scenario building (including the planning, and sharing of the scenarios, the latter to validate and make them understandable and to develop anticipation capacities, among other reasons) and 3) the territorialities in practice perspective, looking at spatial patterns of water-related vulnerabilities. Each analytical lense utilised a specific combination of data collection and analysis within *concertacion* processes as a cross-cutting process.

Water governance configurations

I used an interpretative and constructivist approach when analyzing the water governance configurations, involving an analysis of discourses, power dynamics, knowledge flows and territorialities using qualitative data (from in-depth interviews, focus groups, workshops, web searches and seminars). I used multiple levels of analysis of the water governance configuration, starting from its domains (water, territory and governance and knowledge construction), the object of analysis, the methodology and focus of the analysis as shown in Table 3.1 below.

Table 3-1 Multiple levels of analysis in a water governance configuration

Domain	**Water**	**Territory**	**Governance and knowledge construction**
Object of analysis	Hydrological cycle Water-related risks and vulnerability	River basin Water provision sectors Metropolitan city	Water Governance networks
Methodology	Climate change scenarios Mapping water vulnerabilities	Multi-scalar territorial analysis	Multi-Actor inclusive action research Multi-Level institutions Discourse analysis
Focus of analysis	Water flows	Territorial knowledge on water-related issues	Socially constructed knowledge
Time frame	Long and long term	Short to long	Short to long

The main discourses drawn from the conducted interviews (see Table 3.2) and the social interactions during the scenario workshops and seminars, helped to clarify the storylines related to the city and its water-related context, identifying the drivers of change. The analysis of transcribed verbal sample data during interviews and workshops, in some of our cases, contributed to developing an argumentative analysis for building up a common understanding of the scenarios, the discourses and core arguments throughout the dialogues, interactions and debates.

The process of discourse structuration[68] and institutionalisation was traced, allowing the elicitation of how actors socialised within the frame of such an institutionalised discourse, making visible how they use their positions to persuade or even force others to interpret and approach reality according to their institutionalised insights and convictions even reaching false consensus but instead establishing a dominant discourse which generated a social cognitive dissonance with present and future reality, allowing some denying risks and vulnerabilities. This cognitive dissonance though turns fragile when a disaster finally hits and such previously dominant discourse became weaker, to then start again a process of new discourse structuration pursuing a new discourse dominance (actually in process).

I started from the assumptions that actors have different discourses, perceptions, understandings and knowledge on water-related vulnerabilities and construct core arguments to understand reality and structure their (in)actions, which allow the dominance of a discourse.

Interviews with strategic actors

For tracing the water governance configuration, the main method of data collection consisted of in-depth strategic interviews with key metropolitan actors in the water, city and territory approaches (see Table 3.2).

Table 3-2 Water discourses by water approach: In-depth interviews and workshops

Institutional position of interviewers	**Water discourse/approach***				**Other sources**
	Water as a Good	Water as a Human Right	Water as a Socio-ecological good	Water as a Sector	
International level	7, 8		6		
National level	2, 5	2, 4	4	16	
Academic (international, Latin-American, national)		1, 9		15	
Regional level	14	17		14	LiWA scenario workshops

Metropolitan level					CC adaptation strategy workshops and focus groups
Local level (NGOs and CBOs)		13, 18, 19	10, 11, 19		
Politicians		3, 12			

* by interviewee number

The interviews with nineteen key actors have been analysed about their understandings, opinions and discourses on cities, water and were also identified from the dialogues and discussions about inclusionary processes of scenario building (Miranda Sara et al., 2014) and research reports from the Chance2Sustain programme (2010 to 2015). And web searches of official government documents, newspaper articles and online social media (Facebook and Twitter) dialogues and discussions with citizens were held. This analysis was complemented with the information from focus groups, workshops and ongoing literature reviews, which validated the discourses, which emerged from the strategic interviews.

Scenario building

My entire research has a multi-temporal (towards the future) approach: moving from the analysis of past events and trends (positivism) to scenario building, planning and sharing, anticipating uncertain and unknown futures in the long and longer-term (complex approach). I used scenario building methodologies with spatial analysis, combining quantitative (Population census and water consumption data from 2007–block by block, per water sector and at the metropolitan scale, creating 2040 scenario maps) and qualitative data. For the scenario analysis, I used both a positivist and complex analytical approach, as shown in Chapters five through seven, when building and analyzing the water inequalities scenarios and risk perceptions.

The scenario methodology I used was intended to build consensus and to *concertate* plausible (and possibly contradictory) futures, based on multi-actor dialogue and deliberation, revising ideas, beliefs and mental models or co-creating new ones. This methodology opens ways of understanding the present situation that differs from the business-as-usual trend, and it is contributing to achieving *concerted* decisions that can be legitimised within a broader socio-political context for policy-making and/or even design innovative and concrete new actions (Carrión et al., 2019; Diaz Palacios et al., 2013, interview Arnillas).

Scenario building data collection

As previously said, three processes of scenario planning were applied, cutting across multiple institutional levels and scales. For the scenario building (analysis) process, I used multiple sets of data, further specified below.

I used and helped to build data for climate models for the future, and I also used and analysed spatial data provided by the Lima Municipality, (land use, residential areas, green and ecologically sensitive areas). I also mapped locations of water sources and boundaries of the three river basins (Chillon, Rimac and Lurin). I applied scenario building methodologies and combined quantitative/spatial data and methods (census, water consumption data and scenario

maps created) with qualitative methods (in-depth interviews, workshops, focus groups and seminars).

In both the LiWA and Chance2Sustain projects, we processed from different sources including Sedapal data from the LiWA project, newspaper articles about risks and vulnerabilities, and scientific literature by peers in Lima. In sum, using the secondary census and water consumption data and LiWA climate change models allowed me to create water distribution inequality maps. These maps formed the basis of 2040 metropolitan Lima water distribution scenario maps, contributing to some changes on water and climate change policies into the metropolitan municipality of Lima and to create a common understanding, views and perspectives of the present and plausible future situations from key local to metropolitan and national actors.

The process of the qualitative scenario building was organised with experts, governments, business teams and communities, as an academic exercise with at least three stages: i) identification of the driving forces, each defining the characteristics and options or alternative developments (per each driving force); ii) analysis of the driving forces, interdependencies and definition of the plausible scenarios themselves; and iii) feedback and communication. The process had a multi-hazard orientation and was a collective multi-actor exercise involving small or larger groups that acknowledged inputs from their different knowledge sets, expressed or communicated through storylines and mapping exercises. Iterative processes happened within a wider framework of action-research, highlighting the need to continuously include all actors in the cycle of events where knowledge and decisions were made, constantly evolving and continuously shaping the outputs (such as expert meetings, workshops with key actors, focus groups, community meetings and seminars with society at large).

Territorialities in practice

This thesis recognises multi-scalar territorialities and water trajectories, making visible the lack of governance and management connections between the city, the macro-region and wider ecosystem levels. This approach helps to make visible the high levels of inequalities, vulnerabilities, and fragmentation of governments, local communities, users and civic society groups when dominant and powerful discourse coalitions interact with weak networks which lack the power to shift discursive practices towards changes the situation urgently needs.

Utilising spatial analysis, this research examined how actors ‘position’ themselves and are capable of ‘observing’ the different territorial scales in interaction (or not) with the different governmental levels within and around Lima, following the water cycle and the flows of water. Maps were discussed with key actors and were validated; these were produced with the support of GIS experts of the University of Amsterdam for water-related climate change scenarios based on municipal, water company and census data-based maps. Final maps, based on SEDAPAL commercial connections and billing data were contrasted with corresponding INEI population 2007 census data.

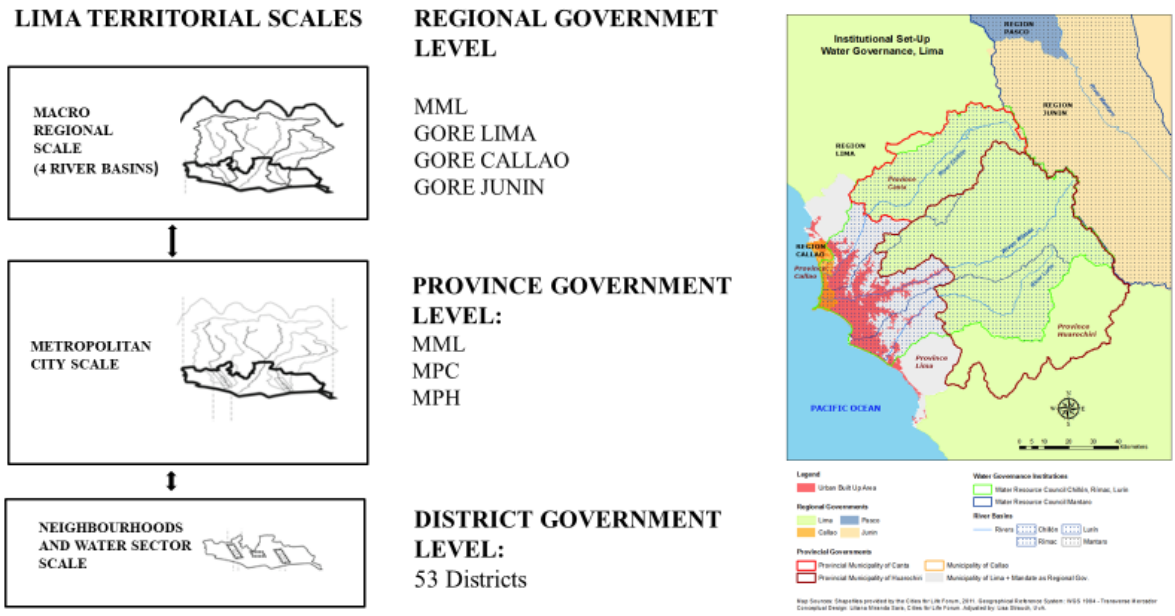
In Chapter Seven, the methodology used collective and iterative mapping processes, using technical, organisational and geographical knowledge from a variety of governance, experts and practitioner networks in Lima. This was done to support social learning by bringing different kinds of knowledge together, integrating several dimensions through spatial representations, raising awareness, increasing capacities for dealing with uncertainties and contributing to climate change adaptation strategies.

In the analysis, we distinguished different positions from where actors observe the Lima water system and its dynamics and the interactions between water, cities and climate change scenarios:

(1) from *outside* the city (from a macro-regional perspective or wider territories, ecosystems and river basins approach generally with a sector 'view' (water, agriculture, mines, industries, construction and energy) within a rural and/or natural areas perspective.
(2) from *inside* the city and neighbourhood or ward level (and in some few cases from there seeing the city with nearby rural zones) and/or 'water sectors' scale (SEDAPAL water management unit of 2km^2 in Lima).
(3) from a multi-scalar perspective (from global, macro-regional, territorial, river basins, city, ward and vice versa) combining an urban, rural and natural understanding of water territories and the hydrological cycle.

The multi-scalar and multi-level analysis helped to examine the way actors define territoriality in their practices, and how that influences their capacity to understand the 'whole' system at the macro-regional and multiple geographical scales, as well as their capacity to understand how pieces of the water system fit into the overall complex water governance configuration to be capable to slowly change its fragmented, sectoral or extremely localised understandings.

Figure 3.2. Territorial scales, government levels in Lima around water



Source: based on maps of LEIS (2014) and Miranda Liliana and Strauch, Lisa (2015). Graph elaborated by the author
Acronyms: GORE, Regional Government, MML, MPC and MPH, Municipalities of Lima, Callao and Huarochiri

Those multiple scales concern territorialities following the water flows; because these territorialities are managed by actors in different sectors, understanding of the complete hydrological cycle is fragmented. The underlying argument is that configuring multiple territorial scales needs to be understood within a holistic and ecosystem approach, including within the global level, the macro-regional level, the river basins, the metropolitan city, neighbourhoods and the 'water sectors' unit. This approach shows the high level of fragmentation and sectorialisation of water management in Peru and Lima and how water-related risks are systematically unknown, ignored or even denied.

Within these territorialities, cities are seen as strategic locations for socio-economic development, where awareness and prevention of future water-related risks need to be built up (IPCC, 2014a). They combine the full complexity of water-related vulnerability issues and how governance processes are embedded in governance networks as discussed in chapter 4. As Figure 3.1 and Figure 3.2 on territorial scales and government levels show, they do not necessarily follow the flows of water in Lima inside the metropolitan city territory, from the macro-regional to the water sector scale.

3.4.2 *Concertacion* processes: a cross-cutting approach and data collection

In Peru, *concertación* processes involving a variety of actors have become mandatory in various contexts. Key characteristics of a *concertación* process are learning-by-doing, combined with constructing knowledge through various actors and actor networks. The latter implies the validation (or contestation) of the knowledge of a variety of participating actors, and an overly sensitive and complex process of dialogue–negotiation–*concertación*–conflict management and consensus-building (or not). This allows actors to contest and confront each other in being heard. Such processes are dynamic, depending on the extent of knowledge and power imbalances, relations, and dynamics. The basic assumption here is that no one actor has the power over a city´s development. This holds true particularly in a metropolitan city such as Lima where knowledge is dispersed, fragmented and/or sectorial among many actors, who lack an overview about the present situation and even less about the whole water-related city´s future.

The methodology used to engage in and analyse such a process included multi-actor participatory action-research, focus groups, multi-scalar spatial analysis, and (co-) generating climate change scenarios, vulnerability maps, and evaluation of capacities to anticipate and generate changes. At the national level, the methodology included reviewing national-level policies, strategies, mandates, and governance networks, along with the social construction of territorial knowledge and consensus for adaptation within *concertación* processes (see Table 3.2).

As mentioned before, the data collection for this research also draws on thirty years of hands-on experience, action-research, combined with fieldwork and interviews in the past eight years while working on climate change adaptation and water governance configuration in Lima and Peru.

Below in Table 3.2., the methods of data collection for this PhD research are described for each specific research question and also in the following chapters (already published as peer-reviewed articles).

Table 3-3 Data collection by each specific research question

Water governance configurations	**Processes of scenario building**	**Spatial patterns of water-related vulnerabilities**	**Risk perceptions?**
Strategic interviews	Workshops	Focus groups discussing maps across scales	Strategic interviews
Dialogues with key real actors	Focus groups	Historical data of water-related disasters	Specific qualitative and spatial risk maps/urban zoning comparisons
Online social media exchanges and discussions	Water modelling from IWS/LIWA	Census data population (by block)	Workshops
Mass media, journals review, social media	Specific qualitative and quantitative/spatial data by driving force	Water consumption Sedapal data (by block)	Jean Paul Kaiser, MSc thesis UCCH (Kaiser, J. 2014)
Seminars	Seminars	Expert and key actor interviews	Institutional web searches
Laws, Codes		Yvonne Leung, Msc thesis, UvA (Leung, Y. 2013)	
Institutional web searches			
Lisa Strauch, MSc thesis UvA (Strauch, L. 2013)			

During 2010, I started with qualitative data, such as in-depth interviews (some respondents were followed for years, see Table 3.1), then moved to workshops, focus groups, seminars and social media dialogues with different actors and the public, which allowed me to maintain continuous interaction with local, metropolitan and national key actors, as well as experts from the international community. Strategic interviews and critical participant observation and conversations during all these years were the basis of my own knowledge building process. Three master students from the Amsterdam University and one from the Catholic University of Santiago de Chile (Miranda Sara et al., 2014; Miranda Sara et al., 2016), whom I supervised during their fieldwork in Lima, also contributed by developing additional interviews, literature review and mapping exercises which I used as a contrasting source of information.

Maps of current and likely future water consumption rates were produced by integrating water consumption data from November 2007 collected from SEDAPAL, population data from the population census (taken in November 2007 by INEI), official population projection rates by district (INEI, census data) and official categories of minimum water demand (WHO). The mapping was done at water sector level, at which level population data were also aggregated.

Events: workshops, focus groups and seminars

Different collective events were developed with the participation of multiple types of actors, thereby avoiding a focus on key actors and interest groups alone. The intention was to involve experts, institutional actors (national and municipal governments), environmental NGOs, academics and community leaders, guaranteeing women and young representatives, from diverse sectors and disciplines related to water, cities, territories and climate risks, bringing them together into a cycle of collective events to promote dialogue, deliberation and mutual understanding as a basis to build up consensus to open up spaces of *concertación*.

We departed from the understanding that the greater the possibility to influence a policy decision, the stronger our ability to involve a variety of participants. To consider challenges imposed by bringing together a diverse group with hierarchical and power relationships and different levels of expertise and knowledge, each event was carefully prepared and designed with at the least the expectation of raising awareness of the potential paths for future development as a good starting point to generate change. Each event was recorded, transcribed and analysed to visualise how the discourses were framed and debated, how the power dynamics and relations worked, if any actor configuration appeared, if any actor was dominant and under which circumstances, how the territorialities shaped in practice recognising or ignoring (or partially) the water flows and the risks attributed to climate change, and what their outcomes were (in terms of universal water provision, security and sustainability of the hydrological cycle).

Those events were workshops, focus groups, seminars, working meetings and high-level expert meetings configuring an iterative and interactive knowledge building process, overcoming practical concerns with regards to political discontinuity, lack of public budget allocation, difficulties and restrictions in time and variability in attendance at meetings, which influenced the final outcomes of these activities. These processes were held as a result of the active support from the Lima Municipality, SEDAPAL the Lima water company and international research projects and cooperation with the active engagement of a wide range of actors, which allowed me to be part of and lead a team which developed the following:

1) Technical expert-oriented scenario building workshops, focus groups and seminars under LiWA project (Miranda Sara et al., 2014)
2) Workshops, fieldwork interviews, focus groups and seminars as part of the Chance2Sustain research project, particularly concerning the work package related to water-related risks and vulnerability, of which I was co-leader (Miranda Sara et al., 2014)
3) Four workshops and meetings for the climate change adaptation strategy for metropolitan Lima as part of the social construction of knowledge, problem-solving and action-oriented research (developed with the technical group of climate change of MML)

Regarding the first set of developments, a substantial part of the work in Lima was directed at supporting the formulation of a climate change adaptation strategy for metropolitan Lima. The LiWA project was led by research groups from the University of Magdeburg, Stuttgart and the Helmholtz Centre for Environmental Research (UFZ) working with the Lima Municipality, SEDAPAL (water company of Lima) and the FORO (Shütze, 2019). Several scenario building workshops were held, where I was an active organiser and participant; a detailed explanation of this methodology is shown in Chapter Six.

I developed three focus groups related to water, urban development and water governance with experts and key actors on the field (5th May, 3rd May and 28th June). The aim of the focus groups was mainly to discuss the drivers of change for the construction of the scenarios and to contribute to defining scenario storylines.

Regarding the second set, one of the most important seminars was the annual Chance2Sustain research meeting held in Lima in September 2013 and Arequipa the same month. The researchers presented fieldwork results from case studies per work package, answering the research questions, and discussed the extent of spatial knowledge generation, exchange and/or exclusion and impact per work package case studies and country, including the degree of (or lack of) participatory processes involved. They also provided opportunities to disseminate the preliminary findings to a wider community of academics, civil society organisers and policymakers in Lima contributing to the city debate. After the Lima C2S research workshop, an open FORO was held at the National Architects´ Association with the active participation of Lima municipality functionaries, the Water Company of Lima, ministries, functionaries and academics, attended by architects, urban planners, journalists, councillors, politicians and activists interested in urban and environmental governance issues in Lima.

For the third set of developments noted above, another set of four workshops and working meetings were organised with an agenda for adapting to climate change for the city of Lima, co-organised with the natural resources and environment manager of the municipality of metropolitan Lima as part of project activities of Chance2Sustain. Those workshops (20th March, 27th June, 2012 and 4th and 5th July 2012) discussed the scenarios generated by climate change in Lima and Callao, risk management against possible natural disasters, water governance, policies and adaptation strategies in the city of Lima with the participation of representatives of national, regional and local government, NGOs and water-related experts.

To this end, the Cities for Life FORO and I initiated, coordinated and participated in numerous events with key-actors, academics and civil society and interacted continuously with opinion makers, media and social media. This in-depth fieldwork included several workshops, working meetings with key actors all over the city, seminars for a wider audience and interviews. This research work was developed in close coordination with the environmental team of the municipality of Lima, the SEDAPAL water company, the LiWA partners (including the national government, academics and private sectors representatives), Chance2Sustain project network, community leaders and with key actors' participation.

The participatory and *concertación* action-research and associated data collection and analysis methods helped to provide answers to the four research questions and the main research question outlined above. In the coming four chapters, each research question is addressed by chapter, while the last chapter will draw out the major conclusions obtained.

Chapter 4. Configuring Water Governance: Actors, Networks, Territorialities and outcomes in Lima, Peru

4.1. Abstract

This article analyses how complex water governance networks and their dynamics in Lima are configured, as well as their implications for urban water provision. We examine how the concept of configuration is assembled through the dimensions of discourses, policy knowledge flows, power relations and mandates across territorialities, and decision-making processes. Together these configure water governance networks in metropolitan Lima and its supporting river basins. The main methodologies used were interviews with strategic actors and community members and action research in advocacy processes in metropolitan Lima.
The results show how political power relations create two dominant networks and how their discourses dominate which parts of the water hydrological systems are recognised or ignored. Emerging networks are including wider communities, but their power remains limited. Overlapping mandates and territorialities in practices and the policy knowledge in use produce uneven outcomes (in terms of universal water provision and sustaining the hydrological cycle). The water configuration faces the paradox that current water demands of all users combined may no longer be feasible within ecological limits and future climate change consequences.
The main conclusion is that a conceptual framework based on a configuration with the dimensions indicated above provides a better understanding of hybrid governance networks, their unequal relational processes and uneven outcomes.

4.2. Introduction

Lima is a capital city characterised by water scarcity, unequal distribution of drinking water and water pollution, endangering the sustainability of the hydrological system. Global climate scenarios for the future (IPCC, 2014a, 2019) indicate that water and sanitation provision is likely to be an increasingly tricky issue, also affecting the Lima metropolitan area (Miranda Sara et al., 2017). The average annual rainfall is 9 mm, the lowest of any metropolitan area in the world. Water comes almost entirely from rivers originating in the Andes, which depend mainly on glaciers that are rapidly melting due to climate change. Although long-term water supply will decrease, heavy rainfalls in the short term also create major disasters (MINAM, 2001, see Chapter Five).

Lima´s hinterland consists of the Lima macro-region, a conurbation of cities and towns within three river basins, each providing water for Lima's consumption: Rimac (41%), Chillon (22%) and Lurin (14%). A fourth also contributes from across the Andes, the Mantaro (23%) (Chamorro et al., 2013; Schütze et al., 2019). The first three originate in the Andean highlands, dropping from the mountains to the coastal desert and the Pacific Ocean and forming three broad valleys, in which Lima is located. The fourth basin supplying Lima flows across the Andean highlands to the Amazon River and the Atlantic Ocean (see Figure 4.1). Its water is partially transferred through tunnels to Lima's three other basins to stabilise the city's water supply throughout the year.

Peru is a highly centralised country, and Lima, the largest metropolitan city, holds over nine million people (INEI, 2007), with almost half the national urban population and over two-thirds of industries, finance, services and trade. It is in the central coastal part of Peru, forming Lima-Callao metropolitan city (expanding to neighbouring Huarochiri province). It holds fourth place on the list of largest cities in South America.

Lima represented 51% of the national GDP in 2016[69]. Decisions on about 70% of the national budgets are taken at the national level (Dammert, 2003; Miranda Sara et al., 2014). Despite many attempts in Peru to decentralise, the country remains highly centralised. Peru has three autonomous governmental levels: national (executive, judicial and legislative powers), regional and local (divided into provincial and district municipalities); each one with its responsibilities, duties and budgets (over 2,000 municipalities manage only 12% of the total national budget).

Lima has high socio-economic inequality among its residents. Unequal distribution of basic services, socio-spatial segregation and severe pollution has led to substantial differences in residents' quality of life (Boelens et al., 2016; Ioris, 2012; Swyngedouw, 2005). Lima's infrastructure has little capacity to deal with an expanding population, and its ageing infrastructure for basic services (SEDAPAL, 2014) is experiencing technical, administrative and corruption problems[70]. Although increasing real estate investments and substantial investments in infrastructure were taking place, some megaprojects have created uncertainties, as corruption scandals associated with the Brazilian company carrying them out have become known (Quiroz, 2013; RPP Noticias, 2016)[71]. In 2017, this led to the resignation of the President.

Lima has three potable water plants, and the largest plant produces almost 83% of the total (La Atarjea) (see Figure 4.1). Moreover, almost 19% of water comes from groundwater (over 300 wells in the city) and the rest from the Chillón river (seasonal); and Huachipa potable water plants (at upper Rimac River basin of Atarjea), (SEDAPAL, 2014). Since 2015, 90% of the wastewater has been treated, but most is discharged into the ocean. Only 5% is recycled and reused in an arid city[72] (Kosow et al., 2013; Schütze, 2015). Five hydropower plants generate around 50% of the country's electricity but relocated surface water flows from the upper to the lower river basin leaving many local communities without access to water on the way (Hommes et al., 2017).

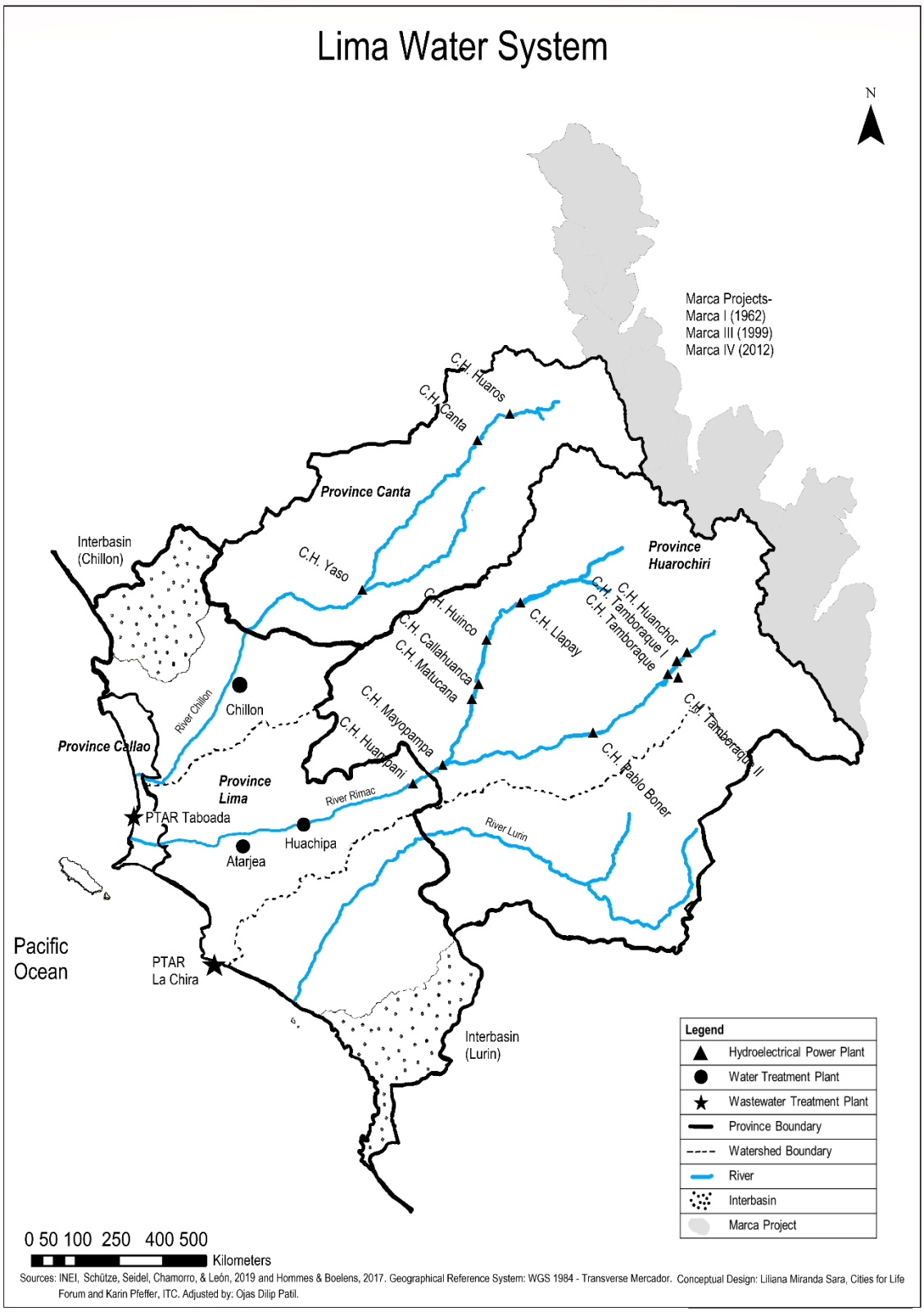
[69] Economy Ministry National budget 2018 per governmental level distribution https://www.mef.gob.pe/contenidos/presu_publ/anexos/anexo3_Ley30693.pdf (accessed 02 May 2018)

[70] In 2017, the Head of the Prevention of Fraud office of SEDAPAL reported 52 prestigious companies were evading water bills with illegal connections or by manipulating meters, owing more than 25 million US dollars. http://www.americatv.com.pe/noticias/actualidad/sedapal-esta-despedir-funcionario-que-luchaba-contra-corrupcion-n287867 (accessed 18 June 2019)

[71] According to Quiroz, corruption costs about 3% of Peru Annual Gross National Product.

[72] Lima has an extremely low 3.6 square meter public green area per inhabitant (MML, Lima Metropolitan Plan, PLAM 2035): 209, 855, non-approved.

Figure 4.1 Lima Water System



Although most residents of Lima receive water, 230 thousand houses still lack connections (around 1.2 million inhabitants), and another million are rationed (SEDAPAL, 2014).[73] Those two million inhabitants only receive 30-50 litres per person/day, contrasting with the over 460 litres per person/day in standard urban areas. SEDAPAL (Servicio de Agua Potable y Alcantarillado de Lima), Lima's drinking water and sewerage company justifies the unequal distribution of water by arguing that poorer inhabitants should only receive limited cross-subsidisation. In reality, people without water connections, who are mainly poverty-stricken, pay five times more than those with private connections (Miranda Sara et al., 2017).

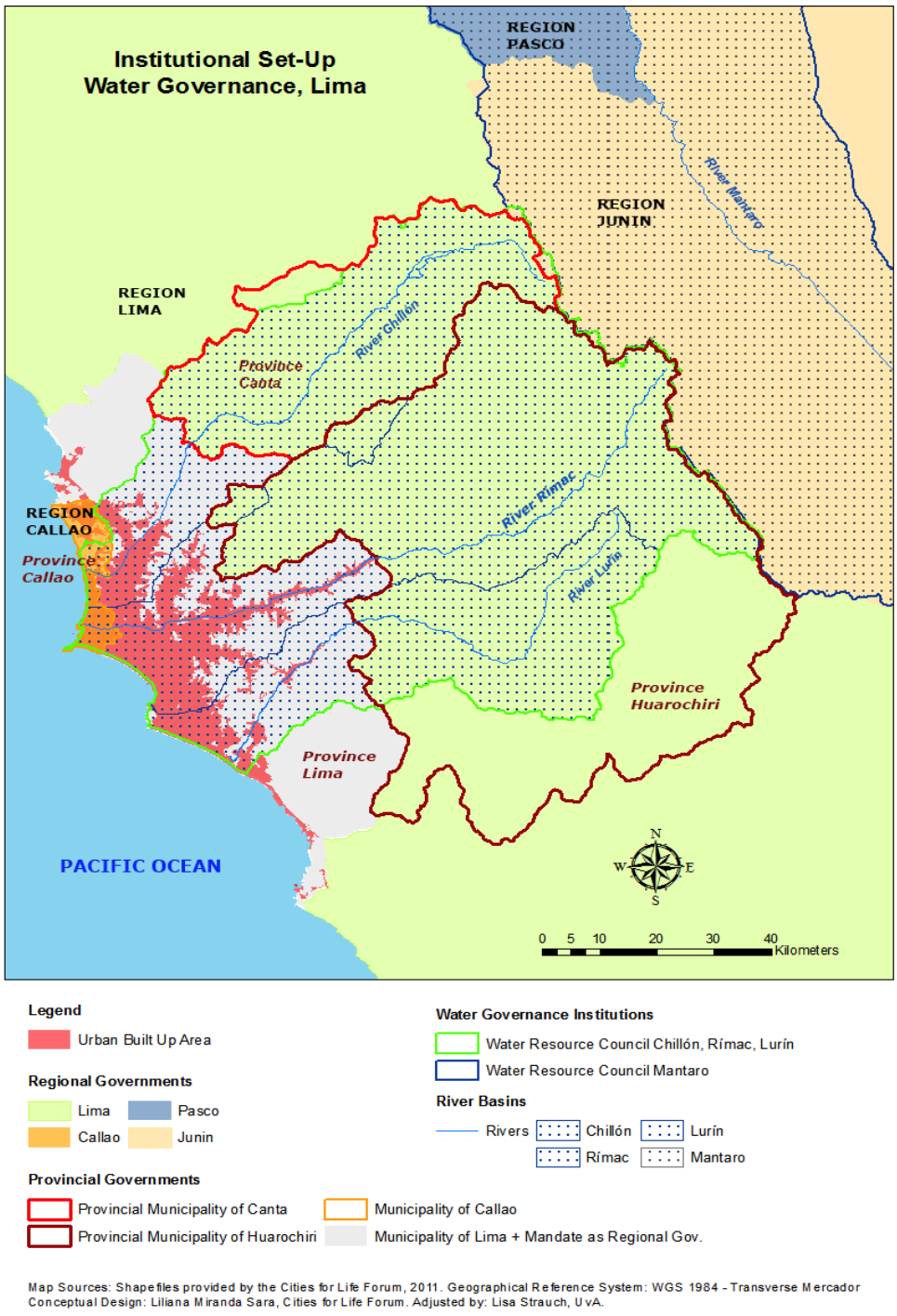
Lima is governed by institutions at multiple territorial scales with overlapping mandates (see Figure 4.2). In Lima's macro-region, three regional governments exist with overlapping jurisdictions and conflicts: Lima, Callao, and '*Lima Provincias*'[74]. These jurisdictions include 11 provincial municipalities (Lima, Callao, Huarochiri, Canta, Cañete, Oyon, Huaral, Yauyos, Barranca, Cajatambo and Huaura) and more than a hundred district municipalities. At the metropolitan city level, Lima is governed by two regional governments: the Municipality of Lima (MML), a provincial government with regional government competencies; and the Regional Government of Callao (GRC), which overlaps with the jurisdiction of the Provincial Municipality of Callao (MPC). Causing even more confusion, the river basin councils have overlapping mandates and jurisdictions with municipal and regional governments and come under the Ministry of Agriculture.

The metropolitan macro-region has water and sanitation services, energy provisions, land policies, large-scale infrastructure and natural resource concessions, largely controlled by the national government and congress, which have legislative, executive and judicial powers. These sector-based and centralised institutions have historically tended to be more powerful than the territorially defined local or regional governments. Recently emerging participatory or '*concertacion*' spaces are usually not strongly institutionalised within water governance networks and have limited power but are helping less powerful non-state actors to influence decision-making processes (Miranda Sara et al., 2014).

[73] See El Comercio newspaper, 31 May 2015, data based in SEDAPAL (2014) http://elcomercio.pe/lima/ciudad/agua-potable-limenos-consumen-5-veces-mas-lo-que-deberian-noticia-1815132 Visited 17 March 2016

[74] Lima Regional Government (GRL), although the name is similar, it concerns a different GRL, whose jurisdiction includes surrounding peri-urban and rural areas in the medium and upper river basins of the Chillon, Lurin and Rimac.

Figure 4.2 Institutional Set-Up Water Governance, Lima



This article takes up mapping these complex water governance networks and their dynamics in Lima, and how their complexity influences urban water system outcomes. We look at what tensions and conflicts emerge from organisations' different mandates and discourses, their power relations, policy knowledge flows, the territories they recognise and/or ignore, and what uneven outcomes they produce. Uneven outcomes are defined in terms of the extent of universal water provision, the differing provision in quantity and quality, affordability and accessibility to water, water-related vulnerability, and future sustainability of the hydrologic cycle (Pahl-Wostl, 2015).

Our contribution lies in the broader debate, providing an approach which shows how urban governance networks are socially constructed through power relations and negotiations, as compared to the theoretically more linear views on 'good governance' and 'participatory governance' approaches. We also show how the networks produce a complex urban water configuration with uneven outcomes for various groups of users; these outcomes are expected to be exacerbated by future changes in the hydrologic cycle (Healey, 2007; Heynen et al., 2006; Pahl-Wostl, 2015).

The approach on how water governance in the urban context is socially constructed recognises state institutions, private sector companies, residents and their civic representatives involved in urban water governance networks (Baud et al., 2015; Pahl-Wostl, 2015). This does not imply that all parties work together amicably, as unequal power relations and conflicts are inherent in such a resulting configuration (Baud et al., 2014; Ioris, 2016; Swyngedouw, 2005). This approach also links water governance and provision to the area's existing hydrological cycle, recognising the water sources and flows that come from outside the city, and distinct actors that use such water flows (agriculture, industry, mines, and residents in the more extensive territory). The approach also signifies the hydrological systems from which water is drawn has to be kept sustainable by limiting water use within their ecological limits of replenishment.

4.3. Theoretical approaches: configuring urban water governance networks and their outcomes

Our analysis draws on the broad theory of urban governance, specifically on the concept of urban governance configuration (Baud et al., 2014; Bulkeley et al., 2014; Healey, 2007; Torfing et al., 2012). Urban governance theory recognises that governments have moved from hierarchical directive state power to hybrid combinations of state power, market mechanisms (privatisation, public-private partnerships, pricing mechanisms), and collaborative governing processes with citizens and/or civic organisations (Healey, 2007). Such shifts have moved the locus of power away from national governments to more hybrid forms of governance networks at different scale levels – both local and international (the re-scaling effect) (Brenner, 2004). Public-private partnerships can have exclusionary effects through their pricing and allocation processes, which do not accommodate poor households (Batley et al., 2001). Governance processes including citizens and civic organisations are said to be more interactive, depicting an array of actors, through multi-scalar relations and iterative consultative processes. However, unequal power relations often prevent giving more voice to vulnerable societal groups (Bulkeley et al., 2012; Torfing et al., 2012). The primary assumption is that hybrid networks and consultative processes can lead to more inclusive and equal outcomes (Bulkeley et al., 2012; Pelling, 2011). In dealing with water issues, utilising an urban governance framework can thus provide more insight into the network of actors involved, their processes of interaction, and why outcomes remain unequal or move towards greater inclusion and equality (SDG Goal 6).

Recently, more explicit attention has been given to how actors (state, private sector, and citizens) interact and negotiate with each other, (re)-configuring a city in terms of outcomes for urban residents (Baud et al., 2014; Bulkeley et al., 2013). This focus recognises that urban dynamics are socially constructed and assembled and cannot be understood without knowing

who is involved and how conflicts and contestations are negotiated to produce new outcomes (Brenner et al., 2011; McFarlane, 2011a). Our main goal in this article is to produce a conceptual framework on metropolitan water governance configurations, setting out the essential dimensions to understand their complexity and analysing the relational processes that shape their outcomes.

Urban governance configurations have earlier been analysed along several dimensions (Baud et al., 2014; Sutherland et al., 2015). These include a) the actors and networks involved, b) their mandates and discourses, c) power struggles around decision-making processes, d) knowledge-building processes and e) outcomes. In this article, we focus more explicitly on policy knowledge flows as a source of power and territorialities of practices (spatial perspective), to strengthen the concept.

Actors involved in urban water governance include users (agricultural, industrial, residents), providers, regulatory agencies (setting standards) and political organisations deciding on discourse and goals, including citizen organisations. These networks differ in power, ranging from strong coalitions aiming at specific goals, as well as emerging networks, where different actors are starting to coalesce around common issues and goals.

Interaction is structured by mandates and policy discourses as sources of power with which they negotiate. The mandates provided through law and practice are based on discourses about water and development issues. Earlier economic, technical, ecological and 'water as human right' discourses are drawn on here (Miranda Sara et al., 2011)[75]. Different sources of knowledge and discourse are recognised, including the use and exchange of policy knowledge (Ioris, 2013; Miranda Sara et al., 2014; Swyngedouw, 2005; van Ewijk et al., 2009). An important issue is the extent to which policy knowledge flows within and between networks, and the barriers that prevent such flows (McCann et al., 2012). Particularly noteworthy is which water issues are taken into account (inequalities in distribution, water regulation and implications of water-related climate change scenarios) (McFarlane, 2011a; Miranda Sara et al., 2014; Shütze, 2019).

Territorialities as spatial categories are socially constructed to define resource domains for politically regulating water. Their institutional and territorial boundaries can reproduce or change inequalities at multiple scale levels and are negotiated and contested (Miranda Sara et al., 2017). First, it is important to study the extent to which the full hydrological cycle is recognised in urban water governance to be able to recognise the human interventions reshaping water ecosystems and water flows (Pahl-Wostl, 2015). Second, territorialities of practices also shape the limits of changes that can provide improvements.

In debates on urban governance, outcomes are usually defined in terms of inclusion and reaching development goals or degrees of 'social justice' (Pahl-Wostl, 2015). Here, outcomes are defined in terms of equality of water allocation (qualitative and quantitative), affordability, and accessibility for all (cf. SDG 6; (Pahl-Wostl, 2015)). However, in recent debates on ecological sustainability, the outcomes for ecosystems are considered equally strategic, given climate change effects already being experienced (IPCC, 2014a; Pahl-Wostl,

[75] These discourses were distinguished by the authors and others in the Chance2Sustain research project (C2S) which was an EU 7th Framework-funded project, examining how spatial knowledge management influences urban development in the global South in areas of economic growth, social inequality and environmental risks (www.Chance2Sustain.eu)

2015). However, discussions about improving water provision in cities rarely include the state of the hydrological cycle and ecosystems on which urban water services draw[76]. In our approach, we also discuss the outcomes of urban water governance in terms of ecosystem sustainability.

4.4. Methodology

This research has used a qualitative, participatory and action-research approach. First, the primary data is derived from in-depth interviews and discussions conducted with sixteen key metropolitan actors in Lima, beginning in 2010. These actors included politicians, national and international experts, national, regional and local government functionaries, water-company, academics, NGOs and CBOs. Their ideas, understandings, values and opinions were analysed to identify their discourses and conceptualisation on water, cities and territories, consultation processes (*concertacion)* and climate change.

Second, over a span of seven years, socio-political decisions, network dynamics and outcomes have been observed, studied and analysed from secondary sources and discussions with key actors. To understand the multi-scalar relations about water issues in Lima, mapping territories and dimensions of the water eco-system recognised by actors was an innovative tool for analysing how various actors expressed their 'position' to analyse and intervene in the water cycle. The water governance configuration in Lima was assembled, following a territorial perspective (macro-region, river-basin, metropolis and neighbourhood), analysing multi-level governance processes and the power relations between the multiple actors involved. Peru involves the largest number of actors in water governance decision-making of all countries (OECD, 2013). Water vulnerability perceptions of residents and key actors, actor networks and discourse coalitions have been analysed utilising the 'configuration' concept built up in the Chance2Sustain project (Baud et al., 2014; Peyroux et al., 2014).

Secondary sources included web searches, official government documents, newspaper articles, online Facebook[77] discussions with citizens, community organisations and scientific literature. Discourses were identified from the dialogues, discussions and mapping exercises about inclusive processes of building climate change scenarios (Miranda Sara et al., 2014; Miranda Sara et al., 2017) and research reports from the Chance2Sustain project (2010 to 2015).

Finally, the first author has long-standing experience as architect and director of a national network, Cities for Life Foro, a network whose purpose is the social construction of knowledge and capacity building for urban environmental management and sustainable development. The author is also an urban environmental activist and former principal advisor of the "Environment and Andeans, amazonics and afro communities Commission" of the Congress of the Republic of Peru. As such, the author has been able to draw on extensive existing networks in Lima and Peru among academics, local authorities, NGOs, government officials and politicians.

[76] We define hydrological cycle as the continuous movement of water on, above and below the surface of the Earth (Wikipedia, the water cycle), accessed 12.04.2018

[77] The first author's Facebook page has 5,000 'friends' and nearly 1,900 'followers' which have contributed in different ways to the discussion and cases analysis.

4.5. Configuring Lima's water governance networks

In this section, we analyse how Lima's overall water governance is configured from several governance networks, each having their own mandates, perspectives and activities within the whole hydrological cycle. We follow the dimensions of the urban water governance configuration outlined above: main actors and actor networks; discourses and mandates; leading power relations among the organisations and actors within each network; the policy knowledge they produce, utilise and share/hide; the territories they cover and recognise, and water provision goals. Finally, we analyse how their complexity and dynamics influence outcomes in terms of equality in water provision and water sustainability.

Four networks were identified which configure Lima's water governance. The first is the dominant policy and investment Network A, in which government and private companies together set policy on water and energy for the country, and produce water infrastructure, including drinking water for urban residents (and private companies). The second is the regulatory Network B, designed to control the actors in Network A and provide consumer protection to ensure quality and access to water. Network C is an emerging network, led by the National Water Authority, designed to promote inter-river basin coordination. Finally, the network of municipalities and civil society groups composes Network D, which has official mandates over water, but mainly brings together dispersed groups who still have to fight to make their issues heard.

Figures 4.3 through 4.6 demonstrate the complexity of the water governance system for metropolitan Lima, with each figure showing the institutions at multiple levels involved in one of the four networks identified above, ranging from international agencies, macro-regional organisations and national ministries to local institutions. The figures include several factors: main legislative and regulatory institutions; institutions dealing with water sourcing; provision and allocation to industry, mines, energy, agriculture, drinking water and wastewater; and organisations involved in discussions on redesigning water governance, such as non-governmental organisations (NGOs), civic organisations (CSOs) and international agencies. Different sectors are indicated by different colours.

The tan underlay shows which organisations are involved in the indicated network.

Figure 4.3 Network A Investors (dominant)

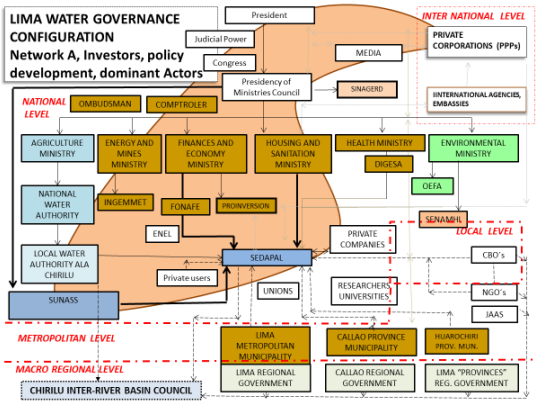


Figure 4.4 Network B Regulators

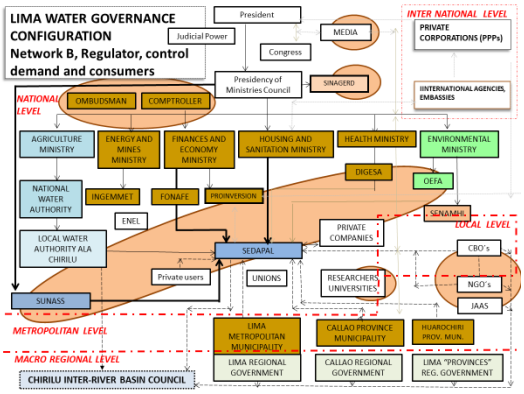


Figure 4.5 Network C Inter river basin

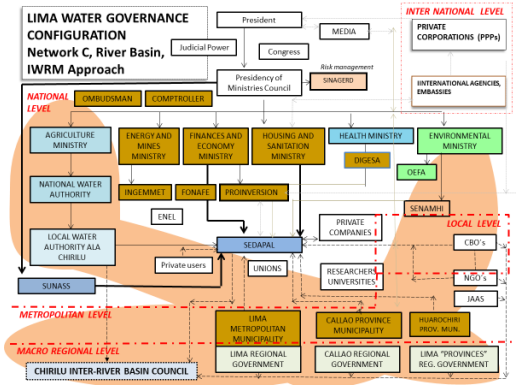
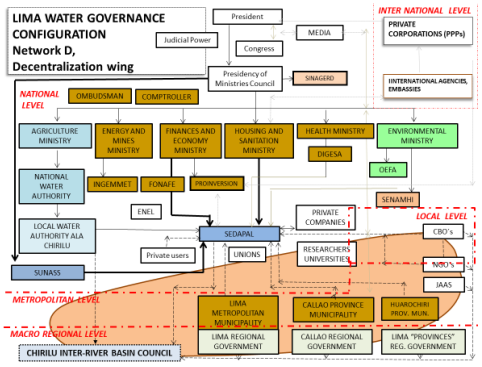


Figure 4.6 Network D Decentralisation



Note: the coloured areas indicate each network of the boxes are sectoral: urban (brown), water (blue), risk (pink) and environment (green).
Source: Author 1, November 2017 updated version based on Miranda, Baud and Pfeffer (2016)

4.6. Main actors, discourses and mandates

This section discusses each network, indicating their main actors, discourses and mandates. **Network A** is the dominant policy and investment network started in the early 1990s when the Fujimori government set up SEDAPAL with little change since (Figure 4.3). Its most important and publicly 'visible' actor is SEDAPAL[78], the largest Peruvian parastatal company which has remained public despite several privatisation attempts, due to massive community mobilisation against privatisation and the politicians' tendency to maintain institutional control for political clientelism.[79] It is controlled by FONAFE[80] (National Fund to finance the

[78] www.sedapal.gob.pe (visited 03 november 2017)

[79] Four privatisation attempts in last 20 years already failed, facing strong resistance from SEDAPAL union workers and those not connected communities, using the example of other failed privatisation processes (Buenos Aires water company returned to Government because it was less profitable than expected). The actual policy emphasises PPP´s under the model of concessions.

[80] www.fonafe.gob.pe (visited visited 03 november 2017)

state's entrepreneurial activity, created by Law 27170 in 1999) and belongs to the Economy Ministry, which collects SEDAPAL's profit.[81]

The Sanitation Vice-Ministry (of the Housing Ministry) sets and regulates water and sanitation standards for SEDAPAL. Although SEDAPAL focuses only on Lima, responsibility has not been decentralised to the Municipality of Lima or any other municipality. The Ministry of Housing[82] and the Economy Ministry[83] (via FONAFE) appoint the President of the SEDAPAL Board of Directors.

The Congress and the President are the most influential members of this network. A powerful and influential legal and institutional framework for this network is the Pro Investment Policy unit promoting private initiatives and public-private partnerships (PPP). Created under the Fujimori regime[84], this entity attracts private sector investments and facilitates privatisation. The long-term concessions by which the government grants a private company the rights to land and property, as well as to exclusively operate public services or utilities, are signed without consultation or participation. The licensing and administrative procedures are finalised *after* the concession is signed. This strategy was implemented after the first attempt to privatise SEDAPAL failed.

Water services in Lima are first subdivided and each section is quietly privatised. These include large infrastructural projects, such as potable water and wastewater treatment plants, built and operated through PPPs, and various services subcontracted to private companies. In this way, privatisation has been achieved for the most profitable activities with little resistance (Ioris, 2013). Completed projects include service contracts with providers, dam concessions, new potable water plants and wastewater treatment plants. In 2016 and 2017, massive protests were held against attempts to privatise SEDAPAL. The public backlash has so far secured support from the then-president to prevent privatisation.

The Ministry of Energy and Mines manages concessions, tenders and contracts with mines and hydropower plants via INGENMET, a vital member of the network. Although not directly concerned with urban water flows, its five hydropower plants utilise the same water source that supplies Lima, while generating 60% of Peru's electricity. Due to the ENEL (private company running those hydropower plants) concession contract, there is conflict and competition for water between urban water providers, power plants and rural communities dependent on Andean ecosystems. The power plants transfer water from the upper river basin to lower areas and may open the dams of the Lima water reserves for public provision if water shortage occurs. This transfer can not only endanger Lima's water reserve[85] but also leaves

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[81] National Fund to Finance Entrepreneurial Public Activities – Law No. 27170- article 4th. '…public companies must transfer their profit to FONAFE.

[82] www.vivienda.gob.pe (accessed 03 november 2017)

[83] www.mef.gob.pe (accessed 03 november 2017)

[84] President of Peru during the 90s, in jail again (after a pardon from former President, PPK) http://www.washingtonpost.com/wp-dyn/content/article/2009/04/07/AR2009040701345.html (accessed 02 November 2017)

[85] According to SEDAPAL interview and the news, in 2004 ENEL opened the sluicegates in order to get water for electric generation, which resulted in water reserves going straight into the ocean, leaving the city without supply in case of drought and with water rationing consequently.

most highland communities without potable water and electricity (Hommes et al., 2017). Notably, in the upper river basin, the need for watering crops or drinking water for animals is neglected. Moreover, the peasants living along Huascacocha and Marcapomacocha would not benefit from such large infrastructure investments; dams built to reserve water for Lima in the Mantaro Upper River Basin will not provide access to potable water provision or electricity locally. Mines and industries in the upper and lower river basin also use large volumes of water (surface and underground) and pay low tariffs for it (Miranda Sara et al., 2017). Furthermore, these mines and industries pollute rivers (Mantaro, Chillón, Rimac and Lurin), diminishing the water quantity and quality of Lima's main potable water sources. This subsidy and pollution increases the costs by around 10 million dollars for SEDAPAL and increases water tariffs for residents[86].

The dominant discourses of the actors in this network consist of 'pro-growth' development and water as an 'economic good.' However, the discourse of 'pro-poor' development and water as a 'human right' is also utilised to publicly justify large-scale PPP infrastructure investments appealing to voters. The water provision in Lima is politicised and oscillates between 'populism' and 'clientelism', parallel with a 'market-oriented', 'efficient', 'innovative' approach.

Network A prefers a high-tech comprehensive infrastructure approach, resisting decentralisation processes of water/wastewater systems that recycle and reuse water, making the hydrological cycle more sustainable. There are no initiatives developed within the city to reduce, separate, treat or reuse water for irrigation or for greening the city. Although almost two million people in Lima have no water connection or limited access to water,[87] the Peruvian government claimed that it had achieved the Millennium Development Goals in 2015 thanks to a substantial investment effort in water and sanitation infrastructure. Despite present and predicted future water scarcity in the city of Lima, Network A does not prioritise a more just reallocation or reduction of water consumption per connection, neither for urban consumers (domestic or industrial) nor for rural ones (particularly mines and agriculture).

Network B regulates and controls Network A. The General Law of Sanitation Services (1994) created a regulatory body, SUNASS (National Agency of Water and Sanitation Services). According to this law, water users become 'clients' and SEDAPAL is considered a para-statal company within a corporative government management approach. The members of Network B see water as an economically profitable resource and maintain a 'linear' view of water in the hydrologic cycle and have members similar to Network A (see Figure 4.4).

Due to the PPP concessions of Taboada and La Chira, SUNASS has recently included wastewater treatment costs in the water tariff. This means SEDAPAL can finally construct and maintain the wastewater treatment plants in the city profitably, although industries and mines are still not yet paying their share.

There have been several attempts to reform the water sector from this way of thinking. One important issue is that of cross-subsidisation in water tariffs. SEDAPAL strongly advocates

86 http://larepublica.pe/sociedad/870943-sedapal-debe-gastar-s-30-millones-para-purificar-agua-contaminada-del-rio-rimac (accessed 18 June 2019)

87 Fuente: Infografía El Comercio 31 May 2015, Plan Maestro Optimizado 2014 SEDAPAL e INEI 2013, http://elcomercio.pe/lima/ciudad/agua-potable-limenos-consumen-5-veces-mas-lo-que-deberian-noticia-1815132 (accessed 18 June 2019)

raising water tariffs and gradually reducing cross-subsidies. SUNASS was designated as 'watchdog' for the city of Lima and the city of Callao for potable water consumer rights. However, SUNASS allows SEDAPAL to raise its tariffs on one condition, that the company demonstrates improved 'efficiency'[88]. Although SEDAPAL claims that tariffs need to be raised to reflect the real costs of the remaining cross-subsidies, it has shown outstanding financial results since 2011. SUNASS suggested that around 100 million US dollars of the newly generated revenues should be invested in infrastructure to provide water to unconnected households.

In 2015, SUNASS made two crucial changes, supported by environmentalist groups. First, it increased the tariffs on municipalities to discourage them from using potable water to irrigate parks. This incentivised district municipalities to invest in decentralised wastewater treatment plants for green space irrigation. Second, SUNASS approved of a 1% increase in water tariffs for investment in traditional water harvesting practices to replenish the upper river basin,[89] which is much less expensive than large infrastructural projects. These increased tariffs have now become mandatory for every water company in Peru from 2017.

DIGESA[90], a part of the Ministry of Health, is the oldest organisation in this network, responsible for research, monitoring and control of drinking water quality and bottled drinking water. The organisation is responsible for establishing and monitoring drinking water norms and environmental standards for the Ministry of Environment and to develop plans and environmental sanitation instruments. A comptroller[91] was created in 2002 as part of the national auditing system for government, promoting government efficacy and increasing transparency of the different governmental entities for Peruvian citizens. It has generated different types of environmental audits and traditional financial audits for SEDAPAL. The objective of such reports is to make practical recommendations for better environmental management and to uphold penalties where environmental management is weak.

OEFA (Office for Environmental Evaluation and Fiscalisation), created in 2009, belongs to the Ministry of Environment and is a 'newcomer' in this network. It evaluates, audits, and penalises contraventions of environmental laws and norms. It also monitors how well different levels of government are fulfilling their competences on environmental evaluation and fiscalisation. It analyses how far industries respect the prohibition of dumping industrial waste into Lima's wastewater pipe system without proper treatment. However, recent legislation diminished its power and capabilities to apply sanctions.

The Office of the Ombudsman in Peru monitors water conflicts nationally, particularly those concerning mine concessions and water pollution. This entity only generates recommendations, which tend to be ignored, although it defends human and environmental rights regarding water. Some representatives of the media and independent audit groups belong to Network B, through which mass media, NGO programs, environmentalists, civic society movements and social media can channel demands from concerned citizens for things

[88] SUNASS raised up again, the water tariff this time reducing water subsidies http://larepublica.pe/economia/1072144-tarifa-del-servicio-de-agua-sube-para-67-de-usuarios (accessed 19 October 2017)

[89] *Amunas,* for example, are an ancient system of canals that funnel water from highland streams back into the mountain to replenish natural aquifers.

[90] Environmental Health Direction www.digesa.minsa.gob.pe (accessed 02 november 2017)

[91] General Comptroller of Peru, www.contraloría.gob.pe (accessed 02 november 2017)

like better quality water provision and support and protection from the water company or water tankers.

Discourses vary widely within this network; governmental entities consider water as an economic value and human right, and this network's members focus on control and regulation, while civil society organisations see water as a socio-ecological good and are worried about its quality and allocation. However, mutual understanding is lacking between these groups, while fragmentation, overlapping mandates, competition and distrust reduce cooperation.

Network C is a structure of networks emerging from the law[92] on integrated hydric resources that was enacted in 2009 (figure 4.5). The law considers water as an essential requirement for life and national heritage of the nation that cannot be privatised, using the word 'hydric' instead of water (as a natural resource). Therefore, it declares integrated water resource management as a matter of national interest. The law created the Hydrological Resources National Management System to coordinate government actions in the river basin ecosystems, as well as to establish spaces for coordination and *concertacion* related to the management of hydrological resources among various actors. The law created the National Water Authority (ANA) as the entity responsible for managing water rights allocation and use nationally, under the control of the Ministry of Agriculture.

The network provides water sector coordination at the inter-river basin level through a river basin council, meant to have a very diverse membership, both in terms of their discourses and interests in water as a resource. However, the 'Integrated Water Resources Management' (IWRM) perspective dominates (see Figure 4.4). It is still unclear which water discourses will prevail in crucial decisions related to water rights, quality and distribution, as well as to what extent the network can counterbalance the influence of Network A. Members of Network C have been active since the Chirilu River Basin Council was started in 2013, developing codes and rules for defining the work of their representatives. The Council was approved in 2016[93], and formally established after a democratic process appointing institutional representatives, but the progress of its activities is quite slow due to strong counter-pressure by members of Network A. The Council is elaborating the Hydric Resources Plan for the Chirilu, stating that other existing plans and projects with budget constraints subsist on grey infrastructure (e.g., from SEDAPAL).

ANA created the local water authorities (ALAs) to administer water rights in the river basins. In parallel, it also created inter-river basins councils at the level of one or a set of neighbouring rivers. The latter includes both government and civil society members. The board of the council formed in Lima consists of representatives from the three regional governments, namely local government, civil society, private sector and others with jurisdiction over the three river basins of Lima[94]. None of the 25 regional governments in Peru has the legal mandate to allocate water rights, a power reserved only for ANA. Thus, while the councils are led by regional governments that include many civil society and private stakeholders in their river basin and region, they do approve the river basin integrated plan,

[92] Hydric Resources Law of Peru, Law No. 29338 http://www.ana.gob.pe/sites/default/files/publication/files/ley_29338_0.pdf (accessed 07 November 2017)
[93] http://www.ana.gob.pe/consejo-de-cuenca/chillon-rimac-lurin/portada (accessed 03 november 2017)
[94] Supreme Decree 007-2016-PCM http://www.ana.gob.pe/sites/default/files/decreto_supremo_nro_007-2016-minagri.pdf (accessed 03 november 2017)

but their limited decision-making power on water allocation means that decisions benefit the interests of the more powerful and influential actors, and not those of local communities.

Network D consisting of municipalities and civil society organisations was established in 1981 when the Municipalities Act mandated the elections of mayors and councillors every four years (Figure 4.6). The Metropolitan Municipality of Lima (MML) was created as a special provincial municipality because of its large population. However, the western part of the city in Callao Province is not included and thus, the city was split across two provinces: each with its own provincial municipality (see Figure 4.1).

MML also acquired the competences of a regional government to avoid the two government levels overlapping in the same territory (regional and provincial), ensuring the smooth functioning of both. Conversely, the province of El Callao kept its regional government separate from its provincial municipality. Therefore, this small part of the city (10% of the urban population) is managed by a regional government, a provincial municipality and five district municipalities. Altogether, Lima's metropolitan area has 52 sub-national governments, all with elected governors, mayors, and councillors: 43 district municipalities in Lima and six in El Callao; two provincial municipalities, one of which (Lima) has regional government competences; and one regional government in El Callao.

The Municipalities Act empowers provincial municipalities to manage water services in their territories. Nevertheless, SEDAPAL, the water company of Lima and El Callao, remains under central government control, and none of the 52 elected city authorities has a member in its board. SEDAPAL's piped water distribution works according to market criteria, with some poor neighbourhoods subsidised while others still lack water connections. The latter have to pay private tankers for their water demand. Until December 2014, the elected authorities of the MML spoke of water as a basic human right. In contrast, the current mayors of Lima and El Callao (2015-2018) utilise a discourse of water as a commodity. The district municipalities of the outskirts of the city are mostly concerned to prevent the disasters caused by seasonal rainfall, as they have self-built their neighbourhoods (around two million inhabitants) on steep and unstable hill slopes with ravines that seasonally become rivers and produce mudslides ('huaycos')[95].

The regional government of Junín, in the Andean mountains, is also a part of the Network C, as its main river provides water to Lima. Junín has relations with the municipalities of Lima and El Callao but also has close relations with SEDAPAL and the Ministry of Housing for building dams and hydroelectric infrastructure, or to authorise mines to use river water.

Researchers, universities, NGOs and civil society platforms are active in this network, including the SEDAPAL workers' union (SUTESAL), although they are weak and dispersed. Some actively participate in protests against SEDAPAL's privatisation and subsidies reduction. People unconnected to the water distribution system are organised in the 'waterless movement' but may not participate in any deliberative council. The JAAS – water and sanitation administrating bodies, which are mainly rural-based community organisations in the upper river basin of Lurin – provide water services to peri-urban and rural communities, but are disconnected from other groups in this network despite being members. They are not even invited to the Chirilu River Basin Councils.

[95] Mudslides caused by El Niño generated 5 days of crisis with a shortage of water provision for more than 6 million inhabitants in April 2017.

4.7. Relationships and power dynamics

Network A includes shared economic and political interests. The central government and powerful private corporations dominate these relations. High-level politicians (President, Minister of Economy) and congress usually support their policies. Although SEDAPAL is the most visible actor, important decisions are often taken outside SEDAPAL. International corporations interested in investing in the water sector often negotiate the concession contracts with the support of their embassies directly with the President or Prime Minister. Moreover, international institutions interact directly with the Vice-Minister of Sanitation of the Ministry of Housing.

This network is closed and robust, with little available information on members' interaction. Mostly, such information comes from research journalists and parliamentary members denouncing corruption in large infrastructure contracts and PPP concessions. These include corruption accusations against former President Garcia and members of his government about SEDAPAL contracts and concessions like the 'Water for All' programme.[96] The Paris Commission[97] (2016) of the Peru Congress recently released a report with findings on Huachipa Potable Water Plant. The report concluded that former presidents, along with other high-level officials from the central government, were involved in million-dollar bribes. Complaints about corruption and lack of transparency are frequent and prevalent.[98] Peru ranks 116th out of 140 countries in 'institutional strength' and 130th in the sub-category of 'bribes to get favourable judgments', making it one of the world's ten most corrupt countries (World Economic Forum, 2015)[99]. Peru also lags in other areas such as 'confidence in police and politicians' and 'security', where it ranks 131st, while for 'judicial independence' it ranks at number 112[100], and according to Transparency International of Corruption Perception Index (2018), Peru scores 35 out of 100. Currently, public prosecutors are investigating extensive corruption emanating from the Lava Jato scandal involving the CEO of Odebrecht, OAS, Camargo Correa and other Brazilian companies.

The media is one of the strong actors in this network. As a group, *El Comercio*[101] is a powerful and influential member whose main stakeholder was the CEO of Graña y Montero, the biggest construction company of Peru and the main partner of Odebrecht. Graña is collaborating with public prosecutors in recognising the existence of the 'Construction Club' to get public contracts by paying bribes[102]. This group has been advocating PPPs as an answer

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96 A widening web, Corruption in Peru www.economist.com/blogs/americasview/2013/05/corruption-peru, (accessed on 19 October 2017)

97 Pari Commission Report 2016, http://diariouno.pe/wp-content/uploads/2017/01/Inf%20Lava%20Jato%20-%20Pari.pdf (The Paris Commission, 2016)

98 In 2015 the Congress of Peru approved a report from the Mega commission investigating corruption and denouncements on 'Water for All' Programme, which recommended the prosecution of former President Garcia and three Ministers. http://utero.pe/2015/09/01/megapost-agua-para-todos-para-dummies-todo-lo-que-necesitas-saber-sobre-el-roche-aprista-del-que-nadie-habla/ (accessed 2 November 2017).

99World Economic Forum. 2015. The Global Competitiveness Report 2015–2016. Pag. 294-295. http://reports.weforum.org/global-competitiveness-report-2015-2016/economies/#indexId=GCI&economy=PER (accessed on 13 October 2016)

100 RPP Noticias. 2016. Perú between the more corrupt countries to get trial sentences. 25 February 2016. http://rpp.pe/mundo/actualidad/peru-entre-los-paises-mas-corruptos-para-conseguir-sentencias-judiciales-noticia-941089 (accessed on 13 October 2016)

101 It sells around 80% of the written media in Peru, Santiago Pedraglio interview May 2015.

102 Institute of https://idl-reporteros.pe/grana-y-montero-inicia-colaboracion-eficaz/

to SEDAPAL's failures to provide water for all (El Comercio, 2014, 2015),[103] and organising roundtables and public meetings to legitimise their discourse and power.

Organisations in **Network B** regulate and control Network A organisations. There are no clear alliances between the organisations in this network, or even between the involved government departments, which reduces its strength. Organisational concerns are narrow and focused, keeping them isolated and without the capacity to control water quality or to reduce the inequalities of water distribution in a more structured fashion. Network B reflects the gaps between discourses on better control and lack of actual implementation. When a former president of SUNASS was reluctant to allow SEDAPAL to increase water tariffs, he was forced to resign. The mandates and power of OEFA and DIGESA have been systematically weakened and reduced in recent years.[104]

Although organisations from central government provide necessary information on river pollution, they have no ability to control, stop or sanction it. Therefore, SEDAPAL finds it costly to produce basic drinking water, given that mining wastewater, industrial and domestic wastewaters pollute the Rimac and Santa Eulalia Rivers.

Although the media, environmental and civil society organisations push to improve water quality and environmental conditions, their complaints are largely ignored.[105] Similarly, the Ombudsman's reports on 'socio-environmental conflicts and recommendations' are not considered unless the central government faces protests from affected communities. In Lima, the waterless movement focuses more on expanding water connections under the 'water as a human right' discourse rather than improving water quality, or reducing pollution, or balancing unequal water distribution. In 2017, SUNASS increased the water tariffs of subsidised water mostly for the middle-class neighbourhoods in Lima, and their first reaction was to investigate whether they would lose their subsidies, after which they focused on current demands. Dispersion, fragmentation and lack of coordination characterise this network and make it essentially powerless.

Since 2018, this network has gained power after the 'Lava Jato' scandals emerged and the contributions of independent investigative journalists such as IDL Reporteros became known (mainly followed by web pages, social media and blogs). These critical reports educated the public and supported the work of a new generation of public prosecutors and judges investigating corruption mechanisms by using the Brazilian company information under Lava Jato, which involved Peruvian presidents, ministers and high-level functionaries.

Network C experiences the water management system at river basin level that remains diffuse and profoundly unfair. Large-scale consumers and polluters of water (mines, industries etc.) pay 110 times less than the unconnected households and rural users in Lima.

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[103] El Comercio. 2015. Potable Water, Lima inhabitants consume 5 times water they should. 31 May 2015, http://elcomercio.pe/lima/ciudad/agua-potable-limenos-consumen-5-veces-mas-lo-que-deberian-noticia-1815132; Sedapal What to do to improve the service?, 24 February 2014 http://elcomercio.pe/economia/peru/sedapal-que-hacer-mejorar-y-ampliar-servicio-noticia-1711764; Water crisis: Lima disorganised growth afects the service, 28 May 2015, http://elcomercio.pe/lima/ciudad/crisis-agua-crecimiento-desordenado-lima-afecta-servicio-noticia-1814692?ref=nota_lima&ft=mod_leatambien&e=titulo

[104] Particularly with Law 30230 from 2014, OEFA suffered another restriction into its competences to sanction polluters which only July 2017 were recovered.

[105] ANA, the National Water Authority presented a Plan to clean Rimac River with support of the South Korean Government, requiring more than one billion US dollars investment.

Large-scale industries have no limits set on the amount of water they use. A court case was brought against a dairy product company concerning payments for using groundwater. According to Legislative Decree No. 148-1982, individual users or companies who utilise groundwater must pay the equivalent of 20% of the regular rate. However, the company disagreed and sued SEDAPAL in 2007, a case which SEDAPAL lost in 2009.[106] However, in 2014, Law Nº30157 for the Organisations of Water Users [107] regulated this situation, putting an end to inconsistency in legislation related to the distribution and control of water infrastructure. The Supreme Decree N° 005-2015-Minagri: Regulation of the Law for the Organisations of Water Users[108] established rules, obligations, rights and functions for water users. Finally, Legislative Decree 1185[109] established the Special Scheme for Monitoring and Management of Groundwater Use, used by Sanitation Service Provider Enterprises (EPS in Spanish).

Now, SEDAPAL is in charge of operating, monitoring and managing urban usage of groundwater in Lima. SUNASS is also responsible for regulating such use and it has increased underground water tariffs to those with higher consumption levels after a long process of consultation. ANA regulates procedures, conditions and requirements to be met by EPSs to get authorisation certificates as service operators. For some experts, this 'is a device that will force (business groups) to pay for the use of groundwater' (Diario Uno, 2015) [110] However, for almost ten years, the government had lost an estimated one million dollars per month (because the law was not applied retroactively). This showed how a lack of coordination and poor performance of two institutions could lead to an under-resourced service.[111]

Relationships within the Chirilu River Basin Council cover two scale levels: the national government level (where ANA is the primary visible member) and the inter-river basin level. Although ANA has a board of directors comprised of representatives from the public, private sector and civil society organisations, including users and farmers, a deliberative space has not yet emerged, as several representatives still have to be appointed and the board needs to approve them. Once this is done, the participation of multiple local actors and water users along the three river basins could increase. Until then, the water company controls water management.

In Network D, the politicians of the central government often try to prevent decentralisation efforts at the municipal level to keep their political status over Lima's vote bank, including human settlements without water connections where efforts to obtain water are ensured by politicians (clientelism). Lima is a major recipient for the national government investment in public works, competing with poorer municipal authorities. In 2012, central government investments in Lima city were almost 29 times larger than those of the metropolitan region

[106] Gloria S.A. y Trupal S.A. vs SEDAPAL, 1837-2009 PA/TC. Sentencia del Tribunal Constitucional (Sala Segunda del Tribunal Constitucional de Arequipa (2009)).

[107] Law Nº30157. Ley de las Organizaciones de Usuarios de Agua. Diario Oficial El Peruano. Lima. 19 January 2014.

[108] Supreme Decree N° 005-2015-Minagri. Reglamento de la Ley N° 30157, Ley de las Organizaciones de Usuarios de Agua. Lima. 3 April 2015.

[109] Legislative Decree 1185. Regulating Special Regime to Monitor and Manage the Use of underground water by Water Companies. Oficial Journal El Peruano. Lima. 15 August 2015

[110] Diario Uno. (2015). Water is a public resource. 27 August 2015. http://diariouno.pe/2015/08/27/las-aguas-son-recursos-publicos/ (accessed 13 October 2016)

[111] Escuela de Gestión Pública. Universidad del Pacífico. 2015. Aguas Subterráneas: ¿Quién paga la cuenta? August 2015. www.up.edu.pe/egp/noticias/columna-jose-luis-bonifaz-agosto/ (accessed 13 October 2016)

(Miranda Sara et al., 2015). The 'Municipalities Act of 1993' undermined the power of provincial governments and empowered district governments (particularly fiscal capacities), resulting in a severe political fragmentation in Lima's metropolitan area that undermined the MML's political influence and reinforces central government's political control. Currently, 52 district municipalities in Lima and Callao urban area make decisions autonomously from each other, from higher regional levels and provincial levels of government. This seriously undermines the potential of coordinating their policies, leaving actual control to the central government.[112]

4.8. Policy knowledge flows

The actual Water and Sanitation National Plan goal is that all Peruvian families have a water connection by 2021.

In Network A, both public and private sector actors rarely share policy and contract information with a wider public. Data on the water market and information on drinking water quality are usually lacking. The contracts and tariffs applied to water-related mega-projects are not usually public. Although water tariffs have increased for all Lima residents due to several new water-related mega-projects, these contracts of PPPs or 'concessions' are discussed behind closed doors before being signed.

As part of its accountability mandate, the Ministry of Housing publishes basic information and policy proposals on its website. They aim at a strong policy knowledge transfer to Peruvian citizens by advocating the concept of Integrated Water Resource Management (IWRM), supported by the general law on hydric resources of Peru, the national policy and strategy of integrated hydric resources published in 2004 and the national policy and strategy of water and sanitation investments. However, the extent of 'integration' in practice remains to be seen and infrastructure investments remain a main priority. Although 'efficiency' is mentioned repeatedly in the law, concepts of 'equity' or 'sustainability' do not appear even once (Boelens et al., 2012; Roa-García, 2015).

SEDAPAL has channelled interaction with civil society and local communities through broadcasts providing feedback on user complaints and for employee´s union resistance to privatisation. It uses water-related climate change scenarios in building a knowledge base for ensuring increased necessary water sources for urban residents in Lima mainly through large-scale infrastructure. Alternatives such as reducing water consumption or controlling increases of urban water demand are not yet a policy priority. In 2017, the central government approved a new law on water and sanitation[113] that included a 1% tariff increase for all water companies and a 4% increase to be used for water-related climate change adaptation measures, encouraging all water companies to develop climate change adaptation strategies with budgetary allocation.

The policy knowledge that flows in regulatory **Network B** among government members is mainly limited to their own group; for corporate governance, 'efficiency and modernisation´ are key concepts. The information and knowledge generated by these network members are

[112]Attempts led Lima Mayor since 2011 to transfer SEDAPAL to the Municipality of Lima or to get a seat on the Board of SEDAPAL, were rejected by President Humala.

[113] Supreme Decree 1280 'Framework Law to manage and to provide sanitation services' http://busquedas.elperuano.pe/normaslegales/decreto-legislativo-que-aprueba-la-ley-marco-de-la-gestion-y-decreto-legislativo-n-1280-1468461-1/

not publicly available, particularly as it relates to PPPs, large-scale contracts for dams, water tariffs applied, and the implications for water user and consumer prices. Most reports are discussed and debated strictly within governmental circles.

However, issues of water and climate change are gradually being connected within policy knowledge flows. In 2015, SUNASS approved a 1% increase on the SEDAPAL water tariff to implement ecological services to compensate infrastructure projects. This tariff increase currently applies only to urban water users, where it has collected around 30 million US dollars in the first year. SEDAPAL has also announced a portfolio of in total 700 green infrastructure projects. Because COP20 was held in Lima in 2014 and after Niño Costero in 2017 it was agreed that every water company in the country, including SEDAPAL, should prepare a climate change plan for members to connect water and climate change issues in cities and their environment, which are gradually finding support within all four networks. International agencies and NGOs have created Aquafondo[114], a fund intended to promote pilot projects to replenish the upper river basin and compensate water over-exploitation.

In **Network C**, Integrated Water Resource Management (IWRM) is the main policy knowledge principle behind the Hydric Resource Law and the Chirilu River Basin Council. International and civil society agencies have successfully advocated for this concept to be included in the Hydrological Resource Law. There has been a strong attempt to integrate the knowledge, discourses and practices of the actors involved in governing the Chirilu River Basin Council linked to the city, although they lack the power to change policies that prioritise large 'linear' water (grey) infrastructure investments (e.g. discharging wastewater into the ocean instead of treating and using it again for the city).

Until 2014, the mayor of MML, the regional governor of Lima, environmental groups from civil societies and NGOs promoted a green and CC adaptation approach, including payment for ecological services to protect water sources in the upper river basins. They focused on closing the hydrological cycle by introducing an ecological infrastructure, eco-sanitation and water harvesting concepts and technologies, as well as supporting various campaigns to reduce water consumption. The 1% water tariff on Lima residential consumption, which was approved, is being used to invest in ecological services using traditional technologies (rainwater harvesting and small dams '*cochas*'). In 2017, this fee was applied nationally and included 4% of the water tariff for adaptation strategies. However, no ecological fee is charged for mining companies, energy companies and industrial users.

There is a serious lack of control and transparency on the volumes of water consumed by major industrial users. Large companies, such as water bottlers, milk producers and mines, report the water consumed directly to ANA without proper metering. If information about the volumes of water available in the three basins, consumption by type of user, and actual rates charged would be publicly available and reliable, the water situation in the city could be assessed more realistically. Now, large infrastructure projects need to guarantee the water supply, given seasonal and permanent water deficits in the three river basins in Lima. However, how much the large commercial users pay for their fair share of water use and the wider environmental consequences are not known.

In **Network D**, information and political knowledge flow more easily. From 2011 to 2014, several spaces for community participation were opened in MML and are again being re-

[114] http://aquafondo.org.pe/ (accessed 19 October 2017)

opened under the new administration of 2019. An independent environment committee was created with contributions from several institutions and individual experts (Miranda Sara et al., 2014). The municipalities of Lima, Callao and Huarochirí do not have their own inclusive strategy, but Callao regional government has included citizens in several instances, of which the online territorial platform is noteworthy (Denis et al., 2013).

Despite the ongoing tension between MML and SEDAPAL, officials from both institutions have signed agreements, for example with the National Statistics Institute to develop an urban base map of the city. The resulting maps have been used in the Metropolitan Urban Development Plan (Metropolitan Municipality), the not yet approved Metropolitan Plan 2035, (2014) and the Territorial Plan of the river basin of Chillon and Lurín (also not approved). District municipalities are reluctant to engage in this interaction. In many cases, inter-district planning councils have helped to make coordinated decisions. Civil society networks, researchers, academics and community-based organisations (CBOs) have been included in different spaces of participation and cooperation but remain dispersed.

Residents of Lima as well as different key actors openly debate development options and proposals to be included in management processes. The waterless movement, NGOs and academics use social media networks to share their knowledge and wider consultation processes but remain weakly organised. In 2016 and 2017, there were protests against the planned privatisation of SEDAPAL. According to the Secretary General of The National Federation of Workers of Drinking Water and Sewerage Companies, Luis Isarra, the privatisation of water is 'against the constitution, because water is a natural resource part of basic needs and cannot be made into a commodity to be traded in the market'.[115]

The Congress of Peru approved in 2017[116] a modification of the Peruvian Constitution, recognising 'water as a human right' and prioritising its importance, although it was brought under economic rights and not basic rights. Manuel Dammert, an opposition congressman, said that 'Water is a right, it is not a privilege, water is not sold, it is not negotiated, it is not privatised'. Former Minister of Housing Carlos Bruce stated that he would not privatise SEDAPAL, but the water tariff has increased, and subsidies have been reduced for over 60% of Lima's water users[117]. Thus, the discussion continues. Generally, the water discourse has been adopted by a conservative political party, which acknowledges the necessity to allow more Peruvians access to this resource but intends to use the private sector and recover the costs mostly from urban residents and not from private sector users.

4.9. Territorialities

The territory of **Network A** covers the 'whole' hydrological cycle of Lima at a macro-regional scale (Figure 4.3). It encompasses SEDAPAL water infrastructure (from the water connections to potable water sources outside the metropolitan city), three river basins, the

[115] Journal La República, 'SEDAPAL privatisation is against constitution' (accessed on 10 January 2016) http://larepublica.pe/impresa/economia/732416-la-privatizacion-de-sedapal-es-inconstitucional
[116] Law 30588 http://busquedas.elperuano.pe/normaslegales/ley-de-reforma-constitucional-que-reconoce-el-derecho-de-acc-ley-n-30588-1536004-1/
[117] http://www.sunass.gob.pe/websunass/index.php/noticias/item/1141-sunass-entra-en-vigencia-el-sistema-de-focalizacion-del-subsidio-en-las-tarifas-de-agua-potable-de-sedapal (accessed 22.06.2020)

upper river basin of Mantaro (involving surface and underground water) and other water sources (e.g. humidity, rain, glaciers, Pacific Ocean, swamps). However, each institution involved has its own jurisdictional map, in which different territorial boundaries are recognised.[118] Most members work mainly at the national territorial level, but their mandates also utilise a sectoral and infrastructural approach, often ignoring the existing links within the *natural, rural and urban* hydrological cycle. This means that most urban dwellers and actors in this network do not easily recognise the rights of rural inhabitants in the upper river basin level, nor the rights of other living beings and ecosystems. They may be oblivious of how cities take water from an upper river basin, put it into pipelines to generate hydropower and/or recharge dams and even discharge it into another river downstream (the Rimac River in Lima's case).

Network B works at two parallel territorial scales:
(1) the metropolitan city level, (Lima, Callao and Huarochiri) where SEDAPAL may provide potable water and sanitation for residential, commercial and industrial water users
(2) the three inter-river basin and macro-regional levels, where the network is concerned mainly with providing water for agriculture and local community consumption, but also competing with mines, energy generation companies and some industries which consume (and pollute) large amounts of water, generating conflict and tension.

The disconnections between both territorial scales weaken the capacity of weaker players to influence policy development and decision-making changes. The Chillón, Rimac, and Lurin (Chirilu) Inter-River Basin Council **of Network C** has no mandate for urban areas, which are considered a different 'water sector' under ANA and Agriculture Ministry leadership, with some tensions with the Environmental Ministry (Figure 4.6). Although the Council's territorial concerns are multi-scalar and the Council itself attempts to involve the whole hydrological cycle, recognising water ecosystems services, its weak connection with the urban water territory, diminishes its influence.

The groups in this council operate at the macro-regional scale. They focus mainly on rural surface water systems but also attempt to generate an inter-sectoral space for more integrated water management systems. The Chirilu Inter-River Basin Council intends to integrate water management systems and to counterbalance the invisibility of peasants and rural community organisations.

Network D territory covers the urban areas of Lima, Callao and Huarochirí, forming the boundaries of the city marked in red in Figure 4.2. In this territory, regulations and competencies overlap between the municipalities of Lima, Callao and Huarochirí with SEDAPAL. Although Peruvian municipal law says that municipalities should represent water users in the directorate of water companies, this does not apply with Lima due to the opposition in network A. Besides, the ANA does not allow water users to participate in the councils (Network B) either. The members of this network are weak and fragmented and have little authority over the territory covered.

[118] The Housing Ministry and SEDAPAL discussed SEDAPAL water rights with ANA, attempting to use water from the upper river basin of Chancay-Huaral (North of Lima). This process stopped after affected agricultural users complained.

4.10. Discussion

This article took up the issue of how the complex water governance networks and their dynamics in Lima are configured, and how they influence urban water system outcomes. We looked at the overlapping factors between different organisations', their different mandates, discourses, power relations, policy knowledge flows, and the territories they recognise and/or ignore, and uneven outcomes they produce. Irregular outcomes were defined in terms of the extent of universal water provision, the unequal provision in quantity and quality, affordability and accessibility to water, water-related vulnerability, and future sustainability of the hydrologic cycle (Pahl-Wostl, 2015).

Our contribution to the wider debate is based on an approach that shows how metropolitan water governance configurations are socially constructed through different discourses and knowledge, power relations and negotiations. This is compared to the more sectoral views of proponents of 'good governance', participatory governance approaches, and how they produce a complex urban water configuration with uneven outcomes for groups of users related to changes in the hydrologic cycle (Healey, 2007; Heynen et al., 2006; Pahl-Wostl, 2015).

The discourses around water were identified in earlier research work through the various urban governance networks. The dominant approach remains one of water as an economic good within a sectoral approach. The discourse of water as a human right (or economic right) introduced in the Peruvian Constitution is used to justify larger investments in infrastructure. Finally, an IWRM approach is emerging but is still too weak to expound and implement ideas of socio-ecological and territorially holistic approaches to water. Climate change scenarios anticipating extreme weather (droughts and floods) are used to emphasise water stress and the need for expanding infrastructure to avoid the measures needed to reduce water consumption and use alternative sources and technologies.

These discourses are linked to the main institutions producing and providing drinking water for the metropolitan area of Lima (Network A). The regulatory Network B has similar views but also includes wastewater treatment, payment for ecological services and climate change adaptation, increasing tariffs, and reducing cross-subsidies. Networks C and D have discourses which integrate more ideas on water provision, ecological sustainability of water sources and recognition of different water users (including all living beings). Specifically, CSOs with rural and environmental backgrounds are coming together in the Inter-River Basin Council (Network C), combining actors that consider water as a commodity, but also including those who want to bring community understandings of water into decision-making processes, and 'the right of all living beings' – *buen vivir* approach (Chavez et al., 2013; Gudynas, 2011). The discourse of integrating water as nature into an urban context (hydrologic cycle) is found in environmental groups in the Lima context (Heynen et al., 2006). Decentralisation to municipalities and social participation is very limited, which gives them little opportunity to develop ideas on the equal allocation of water supply (Network D). In 2019, the recently elected mayor of Lima was appointed for the only municipal member of the board of directors of SEDAPAL, but he withdrew three months later without a proper explanation.

Table 4.1 summarises the networks, discourses, conflicts, territorialities, outcomes and areas of potential agreements from interactions between these networks into the Lima water system.

Table 4-1 Discourses, conflicts, territorialities, outcomes and potential areas of agreement on the water system in Lima (up to 2017)

Network	**Discourses on water** **Water as…**	**Conflicts**	**Territorialities**	**Outcomes**	**Areas of *potential* agreements for better outcomes?**
A Investors, policy developers, dominant network	Commodity Sector	No universal water provision Clientelism Corruption scandals	Macro Regional (4 rivers) To Human settlements	Profitable provision Risk of unaffordability Overexploitation Water appropriation (by private users)	* acceptance of priority in dealing with water scarcity * search for universal provision and ecosystem long-term sustainability * safe (clean) water for all * reduce water related risks (drought, heavy rain, health, biodiversity losses) * climate change adaptation strategies
B Regulators, control, demand and consumers	Commodity (Human right) (Sector)	Privatisation and tariff tension Corruption scandals	Macro Regional (3 rivers)	Increasing (residential) tariff Unequal water tariff (+ 'contributions') and allocation (residents, agriculture, industrial, energy and mines) Distrust Weak institutions New groundwater tariff	
C Inter-river basin	(inter) Sector (IWRM) (Socio-ecological)	No universal water provision Water is also a hazard	Inter-river basins (3 rivers) Metropolitan city	Unsustainable water extraction Water scarcity 1% payment ecological services 4% climate change tariffs adaptation strategies Upper river basin law	
D Decentralisation wing, sub-national governments and civil	Human right (Socio-ecological) (Sector)	No universal water provision Water is also a Hazard.	Metropolitan city To Human settlements	Poor have a higher vulnerability to water-related risks of climate change effects	

society				Municipalities have no decision-making power on water management Actor dispersion Massive mobilisations led Congress to accept water as a human right in the Constitution	

Elaborated by author

Water governance networks have different levels of power and all with little or fragmented accountability to outsiders. Overlapping institutions, fragmented mandates, lack of transparency, and power makes accountability in the B, C, and D networks less transparent. Moreover, the lack of knowledge available, the variety of knowledge needed to deal with both water provision for households, industry, and for maintaining ecosystems sustainably, the fragmentation and difficulty of recognising and exchanging different types of knowledge reduce the opportunities for Networks B, C and D to empower themselves in discussions with Network A.

The information available is diverse, variable, uncertain, diffuse, and confidential. The 'sectoralised' and 'fragmented' water management system, with weak capacities for monitoring and analysis, makes it difficult to understand and analyse the complete hydrologic cycle and the broader water system connections (river basins, metropolis, city, human settlement and dwellings). This means that the better informed and prepared institutions achieve the best conditions in the distribution of water rights, and the poorer and the most vulnerable communities, nature, and ecosystems lose out. Nevertheless, this is an essential support in the political discussions across the networks.

This means that most actors in all the networks have a limited capacity to 'see' the complete hydrological cycle (how water flows through natural ecosystems (surface, underground or atmospheric), and how the institutional system of metropolitan water is connected with *rural and natural* water environments. Also, these actors do not understand how water flows move from rural to urban consumption and then as wastewater into the ocean, or the connection of the large water quantities used (and polluted) by private users (mainly industries and mines) with the water stress and scarcity of water sources for human consumption.

There has been a growing awareness of the need for a territorial approach in recent years given the extremes in Peru's ecological systems. Yet, this is still a challenging task, as sector-based approaches and strong centralism have historically overpowered more territorially integrated, decentralised or autonomous governance schemes. Territorial or more integrated planning has even been postponed[119] reinforcing market rules to manage it.

Finally, the majority of actors can rarely make the connections between current and future water situations, in which the effects of unsustainable water extraction, unequal potable water

[119] In 2017, the Environmental Ministry eliminated the Territorial Planning National Direction with the Supreme Decree 002, 2017. MINAM

allocation connected with low commercial tariffs or the reduction of 'cross-subsidisation', the expected impact of future climate change effects (using scenarios) will increase the future vulnerability of Lima's residents, particularly for poor people. Despite being confronted with different levels of water stress and recurrent water-related climate disasters, only a few key actors have begun prioritising integrated adaptation measures across the territory and along the whole hydrologic cycle, mainly supported by international agencies and environmentalists. Lima approved its climate change strategy, prioritising water-related vulnerabilities approved by Ordinance 1836 by the Metropolitan Municipality of Lima, 2014, but its implementation was slow. However, since 2019, the Municipality has restarted the elaboration of a climate action plan. In 2018, the Climate Change Framework Law 3754 was approved as well as its Code, approved in 2019, which may move the implementation pace faster.

The way actors identify their territoriality affects their ability to understand the 'whole' hydrological cycle and the water system at macro-regional and lower level scales, as well as their capacity to understand how components of the water system fit into the overall water management structure with its current fragmented and sectoral nature. Three perspectives have been distinguished according to their spatial 'positioning' among the networks covering the Lima water system and its dynamics:

a. From outside the city (a macro or regional perspective or from a river basin and/or rural and/or natural area perspective)
b. From inside the city (human settlement level, seeing the city with nearby rural zones)
c. From a multi-scalar perspective (global, macro, regional, territorial, basins, city, human settlement) combining an urban, rural and natural understanding of water territories and hydrological cycle.

What are the implications of this discussion? First and foremost, it remains to be seen whether governance networks become more inclusive and (environmentally) effective when several types of actors are involved. In Peru, the investment and policy network are more dominant than the regulatory one and are not keen to become more inclusive to maintain power over financial investment and system management. The regulatory network is becoming less powerful due to the Lava Jato allegations from Brazilian construction companies involving Peruvian functionaries and is not strong enough to control the investment network on its own, so large-scale systemic corruption may remain in place. The inter-river basin network is emerging and is powerless but could become very strategic in addressing ecosystem concerns (sustainability) and future threats of climate change effects. The network of municipalities, community organisations and SEDAPAL workers unions is weak and dispersed, and it only plays a role in mobilising around demands and humanitarian help after disasters. This means that assumptions about decentralisation improving local services cannot be analysed, as the continuing centralisation in Peru means that central government is relatively strong and dominates in terms of discourses and the sectoral approach, preventing a shift to an integrated water resource management approach (IWRM) and a more integrated water-related adaptation and risk management measures.

The second question concerns the processes of change and possibilities of conflict or inclusiveness. Processes of legal change consist of agreements on new laws, then their administrative codes, and finally their implementation processes. In each phase, a new agreement has to be reached, but equally, tensions and conflict can re-emerge. Discourse coalitions remain dynamic and vulnerable to the undermining of agreements in the subsequent

policy implementation processes. Institutional changes have attempted to shift national water oversight from the Ministry of Agriculture to the Ministers council to reduce its rural agrarian focus but failed. River basin councils have been approved, which is a major re-scaling effort, but the implementation is still caught up in tensions between different powerful actors in Network A, who want to keep control. Preventing the privatisation of SEDAPAL is a repeated effort against the dominant Network A.

The third question concerns changing outcomes, namely the extent of universal water provision, the unequal provision in quantity and quality, affordability and accessibility to water, water-related vulnerability and the future sustainability of the hydrologic cycle.

Agreement on universal provision exists, but there is disagreement on the strategies to implement it. In absolute numbers, SEDAPAL has increased water connections, but it is unclear whether the percentage of unconnected households has decreased or not. Unequal provision remains for different users, with miners, industrial and agrarian users obtaining much more water at prices much lower than urban residential users. There are also high levels of inequality within the city in quantity and quality of water provision, related for water subsidisation by SEDAPAL across neighbourhoods, and lack of access to government-provided water. Water-related vulnerability is related to larger volatility of the hydrological cycle in the region and the resulting lack of water availability at the city and regional levels (Miranda Sara et al., 2017). Lima is a city of water scarcity and vulnerability, and the new volatility and increasing exploitation of other river basins and groundwater are increasing the risks of the hydrologic system in the region, and the related river basins. The recognition of the systemic risk is growing across Lima as a result of the El Niño water-scarcity and recurring flooding and landslides (Miranda Sara et al., 2017).

Outcomes for the future are related to the current discourses and practices:

Universal provision (water for all) without reducing consumption implies extraction beyond ecological limits, where it may be impossible to replenish the hydrological cycle fast enough.
Privatising water produces a conflict with more equitable water distribution linked to water as a human right discourse and linking tariffs to the power to pay will mean that water is appropriated by larger consumers and water tariff inequalities.
Recognising water demands for the future leads to conflict around necessary limits to water use and water scarcity and allocation conflicts in maintaining water provision and urban ecosystems sustainably.
Finally, water as a hazard means recognising disasters and vulnerability (drought, heavy rain, floods and 'huaycos' related to climate risks) in keeping the city feasible economically and livable where high levels of vulnerabilities match with those poorer in water as a sector (where actual infrastructure is not solving it) and water as a socio-ecological good.

4.11. Conclusions

In this article, we have explored the advantages of shifting the approach to understanding water governance from one which focuses on government-led water management to the approach starting from the assumption that water governance is configured by various actor networks interacting in multiple and dynamic ways. The concept of an urban water governance configuration has allowed us to examine how the water governance system is assembled via a powerful dominant network with a modernisation and privatisation discourse and agenda focused on urban drinking water provision. Its power allows it to maintain its

discourse in the face of alternative conceptualisations emerging in regulatory and multi-scalar networks designed to increase equality in water provision, make allocation less competitive between various users in macro-regional and river-basin territories, increase climate change adaptation capacities and reduce risks related to climate change impacts at neighbourhood, metropolitan city and macro-regional scales.

The four actor networks with their discourses and different levels of power to influence policy development (which may move between conflict, negotiation and *concertacion*) were identified, analysed and validated. Their interactions shape the territories where the hydrologic cycle occurs. The dynamics of the networks reconfigure power relations. Those networks face the paradox that meeting water demands of all users may no longer be feasible, given ecological limits and climate change consequences. Opportunities for a different socio-political and technological water governance configuration may emerge based on socially supported agreements (Miranda Sara et al., 2014), which may reconfigure the Lima water system. Having analysed the complex water governance configuration produced in Lima, we turn finally to the implications for future analysis, policy and practice.

Using the concept of urban governance configuration brings out the importance of power relations in shaping discursive practices, as overlapping institutions, fragmentation of territorial mandates, regulatory powers, representation and participation and practices, as well as a lack of accessible, reliable and transparent policy knowledge, all prevent networks from developing a more integrated system.

This research recognised multi-scalar territorialities and water trajectories, making visible the lack of connections between the city, the macro-region and wider ecosystem levels. It also makes visible the high levels of inequalities, vulnerabilities, and fragmentation of local communities, users and civic society groups when dominant and powerful discourse coalitions interact with weak networks, which lack the power to shift discursive practices towards changes the situation urgently needs.

Analyzing the water governance network as configuration allows us to recognise multi-scalar territorialities in one framework and made it possible to examine spaces and actors who could deal with complexity going hand-in-hand with water overexploitation, inequalities and vulnerability, as is the case in many developing countries and countries rich in natural resources. An approach needs to be found combining social and environmental issues, and conflicts, indicating directions to build up new generations of water alliances within multiple territorialities to counter-balance existing power relations and provide different treatment of existing inequalities.

Chapter 5. Unfolding Urban Geographies of Water-Related Vulnerability and Inequalities; Recognising Risks in Knowledge Building in Lima, Peru[120]

Liliana Miranda Sara, lmiranda@ciudad.org.pe, Cities for Life Foro, Peru

Karin Pfeffer, k.pfeffer@uva.nl, University of Amsterdam, Department of Geography, Planning and International Development Studies

Isa Baud, i.s.a.baud@uva.nl, University of Amsterdam, Department of Geography, Planning and International Development Studies

5.1. Abstract

This chapter analyses how different discourses influence knowledge-building processes in terms of their main concerns, water sector boundaries, and types of information considered legitimate, in Lima. It shows how these processes are embedded in urban configurations, and how the legitimacy of mapping processes needs to be negotiated across boundaries. We analyse how iterative mapping processes within three *concertación*[121] processes in Lima reveal uneven geographies of water-related vulnerabilities and inequalities, presenting the outcomes of the cross-boundary processes of social construction for generating, analysing, and exchanging knowledge on water vulnerabilities.

Three research and policy-building projects in Lima reflect how mappings of 'water-related vulnerabilities and risks' are socially constructed. First, maps draw on different discourses and framings, data inputs and classifications at multiple spatial scales. Second, they visualise spatial inequalities and link multiple dimensions to one geographic locality, building a more integrated understanding of the dynamics and spatial differentiation of Lima's 'waterscape', combining human and natural processes. It becomes easier to discuss the legitimacy of different types of knowledge among various actors. Third, maps facilitate 'exchange on priorities, conflicts and synergies', providing inputs into negotiation processes between actors in water governance configurations. Although mapping produces new types of knowledge, it is necessary to ensure that the results are incorporated into policy-making and implemented for wider acceptance.

5.2. Introduction

As the global population becomes urbanised, the growth of large cities in low- and middle-income countries is intensifying water challenges. Such challenges are related to extreme inequalities in providing and consuming drinking water and sanitation for urban populations, the need to deal with future risks and uncertainties around water availability, and vulnerabilities related to climate change scenarios. These challenges are exacerbated when cities are in low-elevation coastal zones, where the effects of climate-related extreme weather patterns are expected to be felt most strongly (IPCC, 2014b; McGranahan et al., 2007). Lima, Peru is a strong case, as the city combines extreme water scarcity (<9 mm/year) and inequalities in drinking water provision with high-risk levels related to climate variability (Miranda Sara et al., 2014). Also, there are extreme inequalities in drinking water distribution between and within central and outlying areas.

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[120] This chapter was published in the book: Bell, S., Allen, A., Hofmann, P., Teh, T. (2017). *Urban Water Trajectories*. Pp. 81-98. Springer Verlag.

[121] 'Concertación' has no proper translation into English. We have discussed the concept el

Local and national governance institutions must assess such risks and devise strategies to make cities more resilient against future stresses and shocks. The water crisis is seen by several authors as foremost a governance crisis (Bakker, 2010; Castro, 2007; UNESCO, 2006). Institutional networks dealing with water provision and water-related risks can be complex, fragmented and not used to collaborating, which limits their knowledge exchange (Filippi et al., 2014; Jameson, 2014). Therefore, it is necessary to better understand the city's different institutional perceptions and discourses about water-related risks and how up-to-date information and knowledge about water issues is built up.

Actors have different discourses, perceptions and knowledge of water and climate change, which they use within their urban governance configurations. Miranda Sara et al. (2011) have identified four main discourses around water and water-related issues, based on how relations between nature and society are recognised. These approaches characterise different water trajectories in terms of sources, flows and uses. They also recognise various types of knowledge and value them differently, as shown by the issues included, and the sectoral and physical boundaries they set to a water governance configuration. We embed discourses within our *concept of urban governance configuration* to capture the links between actor perceptions, knowledge-building processes and power relations, and the way they influence the governance of water-related vulnerabilities, risks and inequalities. The concept distinguishes the dominant discourses and framings around water and water-related issues, the actors and coalitions involved, the processes and methodologies of producing spatial knowledge on water-related issues, the material and spatial scales at which issues are dealt with, data inputs and classifications (together mapping processes), and the outcomes regarding practices (Baud et al., 2014).

This chapter analyses how different discourses influence knowledge-building processes in terms of their main concerns, boundaries set on the water sector, and the information collected recognised as legitimate. We show how these processes are embedded in an urban configuration, where the legitimacy of mapping processes needs to be negotiated across existing boundaries. We look at how iterative mapping processes within three *concertación* processes in Lima reveal uneven geographies of water-related vulnerabilities and inequalities in and around the city, presenting the outcomes of the cross-boundary social construction of knowledge for generating, analysing, and exchanging knowledge on water vulnerabilities (concertación); moving from sectoral to integrated spatial planning.

Mapping different types of knowledge is valuable to understand water-related risks and inform adaptation strategies. Including key actors and local community-based information in knowledge-building processes (mapping) is crucial as it often provides insights not usually acquired through expert-led knowledge building (Allen et al., 2015; Deakin, 2009; Pfeffer et al., 2013). Combining different sources of information in *spatial representations* can be a strategic resource for local deliberative processes. Such mapping helps understand water-related vulnerabilities and trajectories across boundaries, linked to one geographical location within the water hydrological cycle processes. It also creates new understandings as part of interactive and iterative knowledge-building mapping processes (Allen et al., 2015; Kitchin et al., 2007; Muguruza Minaya et al., 2012; Pfeffer et al., 2011). However, maps remain the outcome of subjective decisions, influenced by the social, political and cultural contexts (Pfeffer et al., 2015).

The first section briefly describes the perceptions on water-related vulnerabilities and risks, obtained through 39 in-depth interviews held with key-actors such as SEDAPAL[122], MML, SUNASS[123], researchers, non-governmental organisations (NGOs) and community-based organisations (CBOs). The second section describes the mapping processes of three projects through which climate change scenarios designed plausible future scenarios of the water situation in Lima. These were complemented with focus group discussions, meetings and workshops with community leaders, residents and key-actors[124]. The outcomes laid down in maps indicate likely future patterns of water-related vulnerabilities and risks.

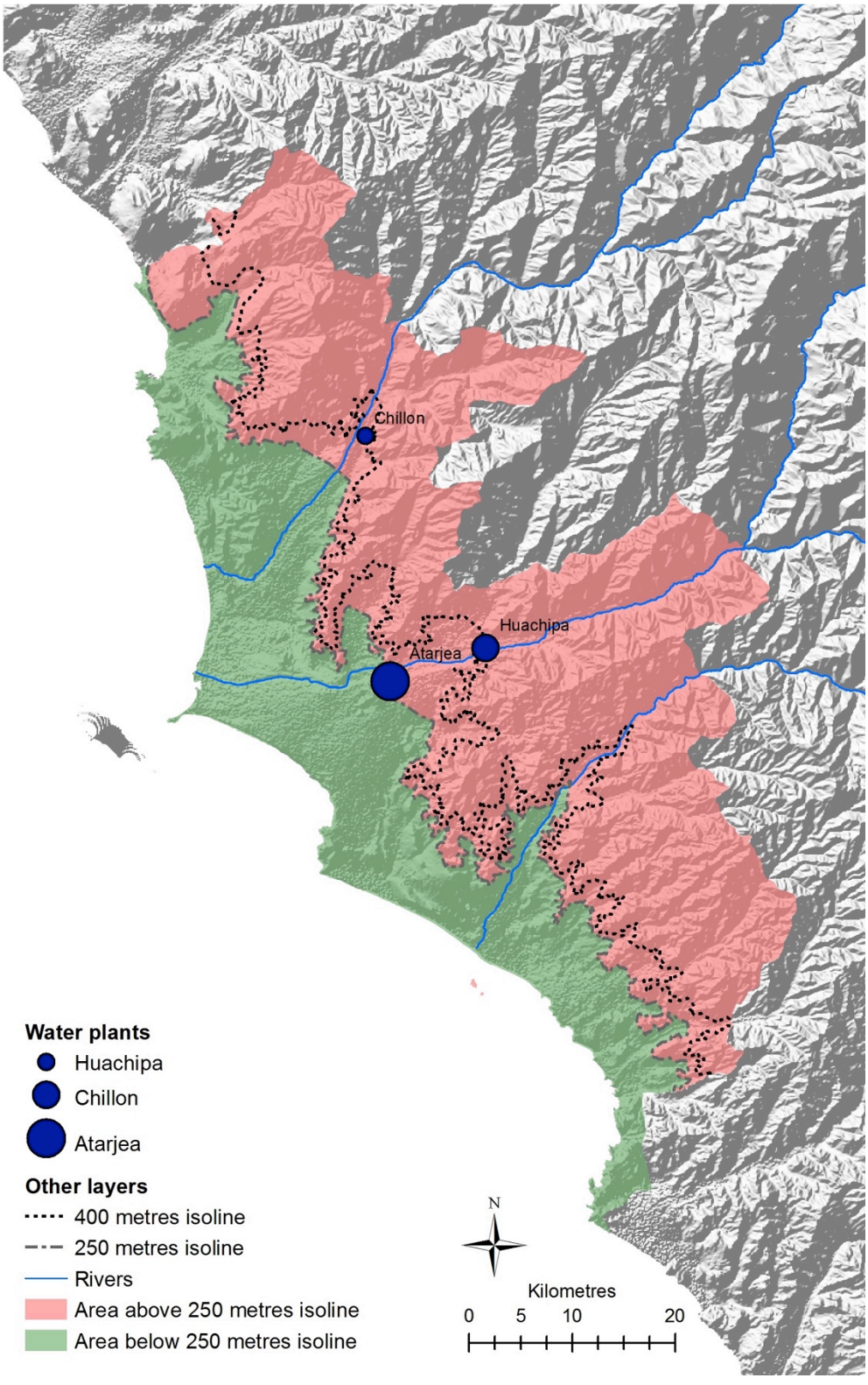
5.3. Water-Related Risks and Inequalities in the Context of Metropolitan Lima; Current Trends and Future Uncertainties

Metropolitan Lima is a coastal city on the Pacific Ocean (Figure 5.1). It consists of about 85,525 urbanised hectares[125]and over 17,000 agricultural hectares under pressure from urban expansion[126]. Lima is the capital city of Peru, with 8.5 million inhabitants (INEI, 2013), one-third of Peru's population. It contains over two-thirds of national industrial production, financial management and trade, and concentrates the highest number of urban poor people in Peru.

The city and its surrounding areas source their water from four basins; three originating in the Andes Mountains and dropping 3,500 meters to the coastal desert and the Pacific Ocean and one being part of Amazon River basin, namely the Mantaro river basin. Although the fourth river basin is part of another basin, its water is partially transferred to the western Lima basin to augment the city's water supply and energy through large-scale infrastructure projects (five hydropower plants contributing 60% of the country's electricity). Underground water extraction is 10% above the replenishment level regularly and goes up to 30% in emergencies. Water is treated, distributed and wastewater released to the Pacific Ocean. It is difficult for key actors to understand and quantify these combined manmade and natural dynamics of Lima's hydrological cycle, as the information remains diffused and confidential (Zwarteveen et al., 2014).

[122] Para-statal water company that supplies and distributes drinking water for Lima, www.sedapal.gob.pe.
[123] The water regulator institution in Peru, www.sunass.gob.pe
[124] Together these consisted of more than 50 workshops, seminars, fora, and focus group discussions. In addition, the first author (as FORO director) was also the team leader in developing the Climate Change (CC) adaptation strategy of Lima and actively participated in the Concerted Development Plan of Lima with the MML.
[125] Instituto Metropolitano de Planificación (IMP), MML Concerted Development Regional Plan, 2013
[126] This area is characterised by a natural system with a mix of biotic and non-biotic elements that support essential ecological processes, including the green coast, island and islets, wetlands, sand deserts and the tillandsias plant vegetation, rivers, coastal ridges and mountains.

Figure 5.1: Lima's topography and unequal water distribution: creating vulnerability



Source data: SRTM, INEI 2007, Chance2Sustain field data 2013

Lima is vulnerable to water scarcity, as river water currently cannot meet the increasing demand for drinking water. Only 1.7% of rainwater flows towards the Pacific side where 63% of Peru's population lives (National Authority of Water, 2014:25). The country's perennial

rivers are in danger from glacial melting, which is expected to generate a temporary increase in flows, followed by a drastic decrease in the volume and regularity of water resources afterwards (Calvo, 2010). There is a growth in frequency, intensity, and variability of extreme and recurring climate events, ranging from heavy rain associated with El Niño and droughts to the La Niña phenomenon (ENSO)[127]. The expected rise in temperature (2°C, minimum) and rising sea level will exacerbate existing vulnerabilities. These factors have led to permanent tensions, competition and conflicts between different water users.

Drinking water distribution in the city is unequal. SEDAPAL, which determines drinking water distribution for the Lima metropolitan area, is owned by the national Ministry of Economy via the National Fund of Public Companies (FONAFE)[128] and ruled by the Ministry of Housing. The city government has no say in its own water distribution. According to the household data of the last census (INEI, 2007), 73.5% of dwellings have access to water connections, and another 7.4% of households have outside water connections or public standpoints. SEDAPAL[129] reported in 2013, that about 13% of houses don't have water connections (i.e. over 1.1 million inhabitants) and nearly 1.2 million receive rationed water for less than three hours a day (El Comercio, 2015[130]; SEDAPAL, 2014).

The city is divided into water 'sectors' (the official unit of water provision by SEDAPAL) of about 2 km^2 each. Water allocation to these 'sectors' varies from less than 50 to over 460 litres per person per day; Figure 5.3 shows the distribution (Miranda Sara et al., 2017)[131]. SEDAPAL provides much more water to those households who, as they say, pay full costs, and to commercial and industrial connections[132]. Households without domestic water connections depend on private water tankers, which cost more and provide water of lower quality. A person without a water connection pays approximately 3.74 USD per m^3, whereas people in non-subsidised residential zones in Lima pay on average 0.83 USD per m^3 [133]. Mines pay only 0.08 USD per m^3 [134].

5.4. Lima's Water Governance Configuration

The actors and institutions involved in water-related activities in Peru are very diverse and often in competition. They work with limited information and usually provide little effort to

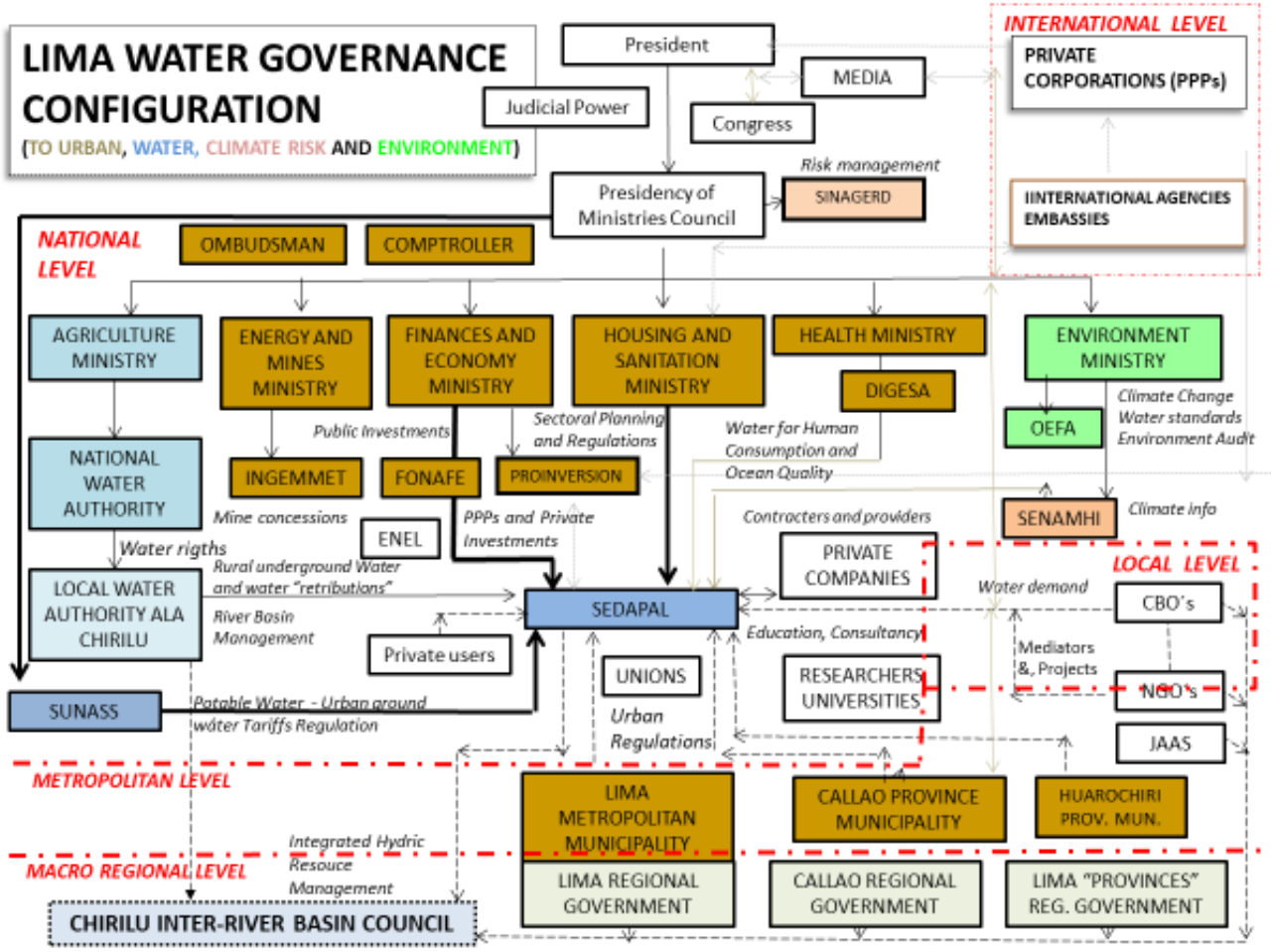
[127] The major effects of El Niño are caused by rising seawater temperatures. This creates high evaporation, which moves beyond the Andes and causes persistent and extreme rainfall, registered since 1911. These have important socio-economic effects on activities like agriculture, communication networks, services and living, which in turn impact the national gross domestic product (GDP), and has a direct effect on Lima's climate (there is a direct relation between the increase of sea temperature and the climate).
[128] This organisation is the National Fund for Financing State Enterprise Activity, which exists since 1999 (www.fonafe.gob.pe).
[129] Cespedes, José (Sedapal) 'Gestión del Ciclo del Agua', presentation in Ecological Infrastructure Course, FCPV, ILPOE, LiWA, 2013
[130] http://elcomercio.pe/lima/ciudad/agua-potable-limenos-consumen-5-veces-mas-lo-que-deberian-noticia-1815132: 'Agua potable: limeños consumen 5 veces más de lo que deberían', Sunday, 31 May 2015.
[131] Based on data from SEDAPAL and the 2007 INEI census
[132] This seems to be related to the subsidised tariff, which a large number of inhabitants of Lima receive, yet which SEDAPAL claims does not give full cost recovery.
[133] The costs estimated were provided in Nuevo Soles and converted to US Dollars on 5 August 2015 through the currency converter available online: http://www.currency.me.uk/convert/pen/usd
[134] www.ana.gob.pe, See Supreme Decree http://www.munizlaw.com/normas/2014/Diciembre/28-12-14/D.S.%20N%C2%BA%20024-2014-MINAGRI.pdf

share data. With restricted resources, their decisions on investment and implementation are rarely coordinated, though improving.

Although governance structures in Peru are usually highly centralised, with power and financial allocations concentrated in the national ministries, water governance institutions are fragmented in terms of their mandates, powers, and the areas they cover (Figure 5.2) (Miranda Sara, 2004). Nationally, the Autoridad del Agua (ANA) determines water rights for the country under the Ministry of Agriculture. As the regions within Peru have very different levels of water availability, this authority is important in determining regional allocation. At the river basin level, a new council is being set up, in which regional governments and the city government of Lima play a decisive role. This council does not include nor connect with the river basin council in the Andes, from which almost 25% of the Lima water is sourced. However, neither the river-basin councils nor the regional governments have the mandate to set tariffs, allocation nor distribution levels, which are the sole purview of ANA.

Lima metropolitan city has numerous authorities whose varied discourses and mandates are superimposed on the same areas. The focus of these authorities also varies: it includes hydrological resources, drinking water and sanitation services, flood risk and climate change management. Although few actors can develop an overview of this complex governance configuration, they decide on the city's development, utilising their own framings for current issues and little coordination about future water-related issues. The context of uncertainty includes the long-term issues recognised in water-related climate scenarios and the context of water governance, where changing political representation risks discontinuity in on-going processes.

Figure 5.2: Lima Water Governance Configuration



Source: author Miranda Sara, L.

The dynamics of these configurations are driven by discursive coalitions, which influence the legitimacy and ability by their dominant discourses, concepts and arguments, which may be incorporated into policy development and decision-making (Hajer, 2006). Within the water governance network in Lima, organisational practices and strategic actions within a wider political context were identified to trace dominant discourse coalitions and their 'representatives' or 'champions'. The way they interact, include or exclude certain actors and build up their relationships in the water governance arena are called an 'urban configuration' (Baud et al., 2014). Such configurations are the means for discourse dissemination and provide legitimisation for policy design and implementation.

The Lima's actors using the dominant discourse of water as an economic good are the Economy Ministry (FONAFE), the regulatory institutions SUNASS, ANA, big private companies, influential international agencies, and technical universities. Their thinking dominates policy development and decision-making, excludes participatory processes, and maintains the power of traditional power holders. The discourse of water as an economic good is linked to the discourse of Integrated Water Resource Management (IWRM). However, their focus on sectoral and centralised urban water management systems persists, with an emphasis on large-scale infrastructure projects decided at the highest political level and implemented through public-private partnerships, whose contracts have little transparency and are generally

contested. This configuration's discourse is not yet supported by in-depth spatial knowledge building in Lima.

The actors promoting a sectoral (with an infrastructure focus) discourse are SEDAPAL, the Housing Ministry, construction companies and civic society organisations. Although SEDAPAL is the most visible entity in this water governance configuration, it remains under FONAFE's control. SEDAPAL produces internal information and worked with the LiWA project to develop knowledge on future trends. It explicitly excluded other partners from access to such information; particularly civic organisations.

Some actors also utilise water as a human right discourse in their discussions. These include community-based organisations (CBOs), civil society organisations (CSOs), NGOs, municipalities, regional governments, SEDAPAL union, some researchers and universities. Whereas the socio-ecological perspective focusing on nature-society relations remains weakly represented (some municipal departments, environmental NGOs, youth organisations, peasants, some researchers and universities).

Generally, organisations responsible for generating information to measure city-wide vulnerability, adaptation capacities and socio-economic trends belong to national government ministries and not municipalities. However, these national and local institutions lack the budgets to expand and update information. Some information is scattered among various actors or not acknowledged, weakening local governments' role. Examples include the cadastral offices at municipalities, which draw maps at block scale and by district, but do not produce risk maps (which are mainly done by INDECI[135], drawn only at the district scale, and not the surrounding territory). Similarly, river basin and water flow maps are produced by ANA (maps drawn at macro-regional scale) which both are difficult for municipalities to access. Maps also do not match each other, so capacity for risk perception for wider territories and water flows becomes inaccurate or non-existent. The effect is that no organisation is mandated to integrate and save information about the whole hydrological cycle, including freshwater (rain, surface, atmosphere and underground), drinking water provision, distribution, sanitation, river basins, humidity and the ocean. Therefore, the effects of extended water sourcing, unequal distribution and quality of water supply between industries and residents, and within Lima itself, are largely unknown and rarely a point of argument.

The city's water governance configuration is complex and fragmented. However, several projects, which include interactive knowledge-producing processes, are supporting actors in the governance configuration to deal with future challenges. The LiWA project producing climate change scenarios was the combined effort of several German universities, the water company SEDAPAL, the Municipality of Lima (MML) and the FORO[136]. The second project was the Chance2Sustain project on sustainable city challenges, based on a consortium of research groups from eight countries, including the FORO[137]. The third project was the work

[135] Civil Defence National Institute, see http://sinpad.indeci.gob.pe/PortalSINPAD/Default.aspx?ItemId=74 (visited on 31 August, 2015, you can only open them with a password not easily known.)
[136] LiWA stands for Sustainable Water and Wastewater Management in Urban Growth Centres Coping with Climate Change - Concepts for Lima Metropolitana (Peru), a German sponsored research project of several German universities where the water company SEDAPAL, Cities for Life Foro as well as MML were actively involved. http://www.lima-water.de/es/index.html
[137] Chance2Sustain is the acronym for the research project 'Urban Chances, City Growth and the Sustainability Challenge'. http://www.Chance2Sustain.eu/7.0.html; funded by the EU Seventh Framework Programme. The Technical Group for the development of the LMCCS wrote the Strategy Paper, which was subsequently submitted to the MML, and accepted by the council.

by the Technical Group for developing the Lima Metropolitan Climate Change Strategy – within the environmental commission of the Metropolitan Municipality of Lima (MML) (Miranda Sara et al., 2016)[138]. These projects have built current and future knowledge on water scarcity and vulnerability related to climate change using different discourses and sources of data. Following the discussion on concertative decision-making processes in Lima through these three projects described in Miranda Sara and Baud (2014), this chapter traces the genealogy of mapping in these projects (in which the authors participated in over the last six years). They are described in the next section and draw together relevant actors with their different discourses about water, to reach a certain level of consensus in defining the drivers of future trends laid down in recently developed scenarios.

5.5. Mapping and Knowledge Building Processes and Water-Related Risks in Lima

This is how mapping took place to build knowledge within three projects based on various concertación processes. The LiWA project produced non-spatial climate change scenarios, outlining the potential effects of specific drivers on Lima's future water situation. The Chance2Sustain project created maps analysing the different scenarios, which were used in the MML's third project for iterative consultation and policy development to outline the implications of future water-related risks patterns.

First, the LiWA project gathered actors from international technical academic networks in the public and private sector to identify and analyse the drivers of socio-economic and environmental change in Lima. A model, provided by LiWA partners, was applied to compose three plausible climate scenarios based on the drivers of change, described below in Table 5.1 (Miranda Sara et al., 2014)[139].

Second, the Chance2Sustain project's *concertación* process included a wider range of actors from the inter-institutional network FORO, international academic institutions, Peruvian NGOs, informal settlement communities and the water governance network (cf. (Miranda Sara et al., 2014)). These actors discussed how water governance is framed and the discourses used when the topic is approached. Community perspectives on water-related vulnerability were acknowledged within a multi-scalar spatial approach and were used to model the vulnerabilities in Lima's water governance network.

Third, the MML climate change adaptation strategy and concerted city development project considered different discourses on water governance and the city's development. The new legal framework mandates called for a larger network of actors to be involved in discussions, such as NGOs, citizen service organisations, community-led groups, experts from various backgrounds and political representatives. This inter-institutional coordination also provided a path towards developing a discourse on transitions to adaptive capacity (Miranda Sara et al., 2014).

[138] The MML project sponsored by AVINA and developed by Cities for Life Foro was participatory and concertatively developed with the climate change technical commission of the Environmental Commission of Lima Metropolitan Municipality, the Strategy has been approved by MML in 2014.
[139] In the LiWA project, opening up to water governance framings and taking wider ecosystem issues into account, proved difficult, and the 'products' remain academic, with little that can be practically applied so far.

Table 5-1: Three plausible water-related climate change scenarios for Lima in 2040

Scenario 1	Scenario 2 (Combination of 1 and 3)	Scenario 3
Higher frequency of 'El Niño' (ENSO), almost permanent	Higher frequency of 'El Niño' (ENSO), alternate conditions of scenarios 1 and 3	Climate gets colder, similar to 'La Niña'
Heavy rain; rain increase over 6% (normal 9 mm per year over the city but higher in the mountains surrounding the city)	Almost permanent dry periods with more heavy rainfall peaks	Rain decreases by about 9.6% => leading to droughts
Temperature increases, at least 2°C (heat waves)		Temperature decreases (cold waves)
6.28% increased water flow		13.72% decrease of water flow

Source: Adaptation Strategy for CC MML, Project MML / Foro Ciudades para la Vida / AVINA, CAS-2011 (Expert Workshop MML 2012, LiWA 2012, IWS/ZIRN, Eduardo Calvo, IPCC)

The LiWA model, which outlines future uncertainties related to plausible climate change effects, was assessed through several rounds of consultation and research with the project partners. Table 0.1. shows the climate change scenarios for 2040, incorporating the possibilities of drought and heavy rainfall and worst-case scenario, combining permanent drought with increased recurrence of heavy rainfall events. The outcomes from the scenarios (an increase of droughts, decreasing water resources by over 13%[140]), were combined with projections of population increase (see Table 5.2) and showed that water stress and unequal distribution would worsen unless specific measures were taken.

[140] Bardossy A, Jochen S, Chamorro Alejandro, 2011. Modelamiento del Clima y Balance hídrico de Lima. Proyecto LiWA- IWS- Universidad de Stuttgart, confirmed later by ANA studies.

Table 5-2: Number of residents with less than 50 l/day, according to population growth and water resources assumptions under 2040 climate change scenarios
(n.a. = not applicable)

Scenarios	Situation (2007)	Realistic population growth, 1.3%	High population growth, 2%	Low population growth, 0.3%
No change in water resources	609,080	1,672,866	2,972,093	713,902
Increase in water resources (+6.28%)	n.a.	1,427,204	2,612,837	678,166
Decrease in water resources (-13.7%)	n.a.	2,348,109	**4,020,022**	961,876

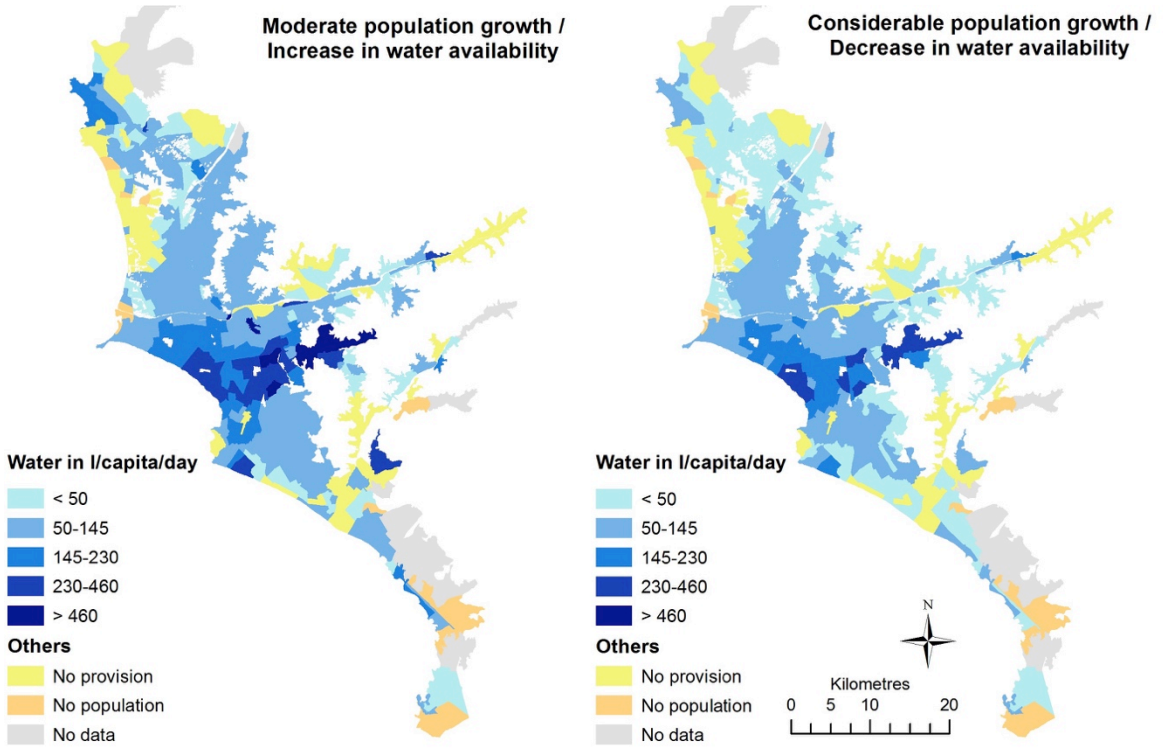
Source: INEI[141] (2007); estimations towards the future based on 50 l/pp/day

Table 5.1 was used by the Chance2Sustain project to produce maps capturing the spatiality of water-related issues and estimate current and future water consumptions at city level based on current and future population numbers (Table 5.2). Two mapping processes were carried out. Participatory mapping revealed the perceptions of residents current and future vulnerabilities from three settlements. Maps of current and likely future water consumption rates were produced by integrating water consumption data from November 2007 collected from SEDAPAL, population data from the population census (taken in November 2007 by INEI), official population projection rates by district (INEI, census data) and official categories of minimum water demand (WHO). The mapping was done at water sector level, at which level population data were also aggregated.

Future water consumption was calculated based on estimates of future water resources (no change, increase of 6.28%, a decrease of 13.72%, determined in the scenario-building processes within the LiWA project) combined with different population projections – (realistic growth (1.3%); pessimistic growth (2.3%); optimistic growth (0.3%) which vary by district). Figure 5.3 displays two contrasting scenarios – moderate population increase and more water, considerable population increase and less water. The maps in Figure 5.4 show estimated future water consumption if an equal provision of 90 or 150 l/day to all residents of Lima is assumed. The maps were discussed in five workshops and various seminars with key-actors and experts and continue to be used.

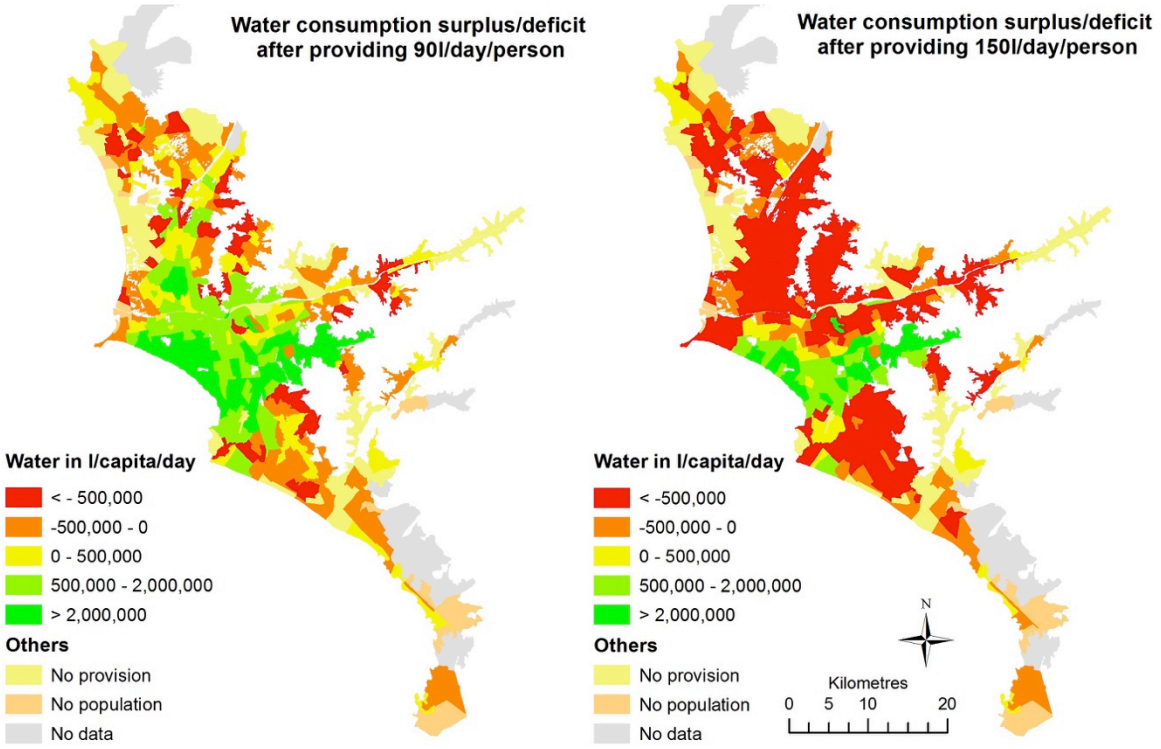
[141] INEI, Institute of National Statistics and Information of Peru

Figure 5.3: Increase in water availability, combining population growth and future water consumption estimates, without changing existing unequal distributions.



Source: SEDAPAL consumption data 2007, INEI (2007) Chance2Sustain project, produced by Pfeffer, Miranda Sara and Kesarovski (2013)

Figure 5.4: Strategy: implementing equal water distribution across Lima



Source: SEDAPAL consumption data 2007, INEI (2007), Chance2Sustain project; produced by Pfeffer, Miranda Sara and Kesarovski (2013)

The city's water plant, however, is at 250 metres altitude isoline, meaning over 1.6 million inhabitants above the isoline will be more vulnerable to a reduced water provision[142] (Figure 5.5).

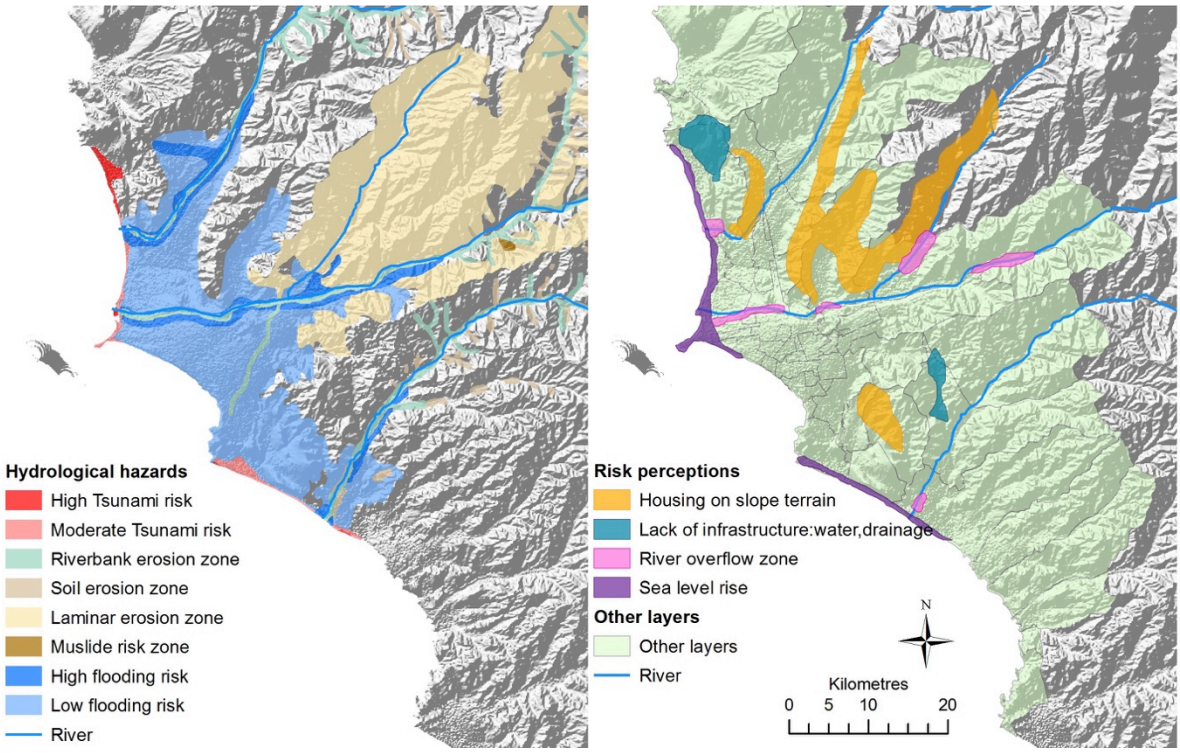
The maps made by the Chance2Sustain project were brought into the MML's third project, in which a new climate change strategy was developed and approved at city level. Although they were not used in the concerted development plan, because the MML lacks the mandate for water allocation, the issues of water stress and vulnerabilities were in maps produced in the third project.

Figure 5.6 contrasts two maps showing such risks, one summarising hydrological risks identified by experts of IMP/MML (International Development Research Centre, 2012) for the whole Lima Macro-region (flood, mudslides and sea-level rise) and the other showing the perceived water-related vulnerability by key actors involved in climate change strategy technical group discussions, IMP and other key actors. The experts of IMP/MML identified that almost 50% of the Lima territory experiences water-related vulnerabilities exacerbated by intense rainfall[143]. These events would have strong social and economic effects on the infrastructure of activities like agriculture, communication networks and services, and negatively affect GDP.

[142] Given the dependence on hydroelectric generation (more than 60% in Peru), under a water scarcity scenario, energy to pump water will be a problem too.
[143] A recent study by CENEPRED (2015) identified more than 7 million inhabitants in danger of a heavy rainfall in Lima facing upcoming ENSO 2015-2016.

Just a few months after the MML climate change strategy project ended with workshops and technical group discussions, participating actors were asked to mark vulnerable areas on the Lima map[144]. It became clear during interviews that participants generally perceive the expected climate problems to affect a much smaller area than indicated by experts, even though most participants interviewed were part of the technical committees on Climate Change of the Municipality of Lima and the Regional Government of Callao, and some prepared the concerted development plan, 'Plan de Desarrollo Concertado de Lima'. The results in Figure 5.6 show that on average, participants indicated only 20% of the areas identified as vulnerable, even though all those interviewed were involved in IMP/MML workshops and discussions and recognised water governance and climate change as a priority.

Figure 5.5: Hydrological hazards in the Lima macro-region in contrast with the perceptions of vulnerability by key actors



Source: Left, from IMP/MML/CENCA (2011), Chance2Sustain project. Right, from Kaiser (2014)

[144] This was on individual anonymous basis.

This section concludes by comparing the actors, knowledge, data and outcomes of the processes discussed (Table 5.3).

Table 5-3: Types of actors, knowledge, data and outcomes

Dimensions	**Expert-scientific**	**Codified**	**Context-embedded**	**Tacit/social**
Actors/networks	LiWA research project	Academic researchers from C2S	Professionals working in water-related sectors	CBOs, CSOs, residents
Sources/data	Data related to water supply including meteorological data;	Census data 2007 Water consumption data from water provider (SEDAPAL) Poverty map (Sisfoh)	Workshops, interviews, forums, advisory committees, consultations	Interviews; participation in scenario workshops; pictures
Processing	Scenario processes; Mathematical modelling;	Population projections (0.3%, 1%, 2.3); GIS mapping	Social knowledge construction using maps as input	Spatial mapping; google maps as platform
Outcomes	Climate change drivers; scenarios (+6.28/-13.72)	Maps representing water consumption per capita and water inequality, poverty	Advise/contributions for mapping water inequalities	Maps presenting water vulnerabilities perceptions

5.6. Knowledge Building in Lima: Discourses, Mapping, and Understanding Spatial Inequalities in Water-Related Risks

The three research and policy-building projects reflected the variety of how understandings of 'water-related vulnerabilities and risks' are socially constructed. In the LiWA project, a scientific model was built up with internal evidence from the main water providing institutions and other government sources focused on developing future climate change scenarios for Lima. The LiWA project results were utilised by the Chance2Sustain research project to map spatial and social inequalities resulting from existing patterns of water-related vulnerabilities, risks and expected climate change impacts. This provided additional insight from strategic interviews and recognised spatial inequalities, before and resulting from the current patterns of water provision and future shocks and stresses. These research outcomes were fed into policy-related discussions and into developing Lima's Climate Change Adaptation Strategy (Miranda Sara et al., 2014). This process benefited from the existing culture of *concertación*, which provided inclusive spaces [145]in which more types of actors could meet to debate issues, negotiate solutions and develop proposals for action.

Mapping has strongly contributed to such discussions and understanding water-related vulnerabilities, inequalities and multi-scalar issues. First, the maps draw on different discourses and framings, data inputs and classifications at multiple spatial scales. Second, they visualise spatial inequalities and link multiple dimensions to one geographic locality. Combining multiple types of knowledge (cf. Table 5.3) they built a more comprehensive understanding of the dynamics and spatial differentiation of Lima's 'waterscape', combining human and natural processes (Gudynas, 2011; Swyngedouw, 1999). It became easier to discuss the legitimacy of different types of knowledge (construction) among several actors who acknowledge, contest to or intend to deny mapping results.

Third, maps facilitated 'exchange on priorities, conflicts and synergies' (Pfeffer et al., 2013), by providing inputs into negotiation processes between actors in water governance configuration and networks. These multiple knowledge types and generation processes allowed different actors to bring in diverse types of knowledge and visualise the perceived social and spatial water inequality. Fourthly, constructing iterative data in projects dealing with water vulnerabilities and climate change impacts, using maps and including many types of knowledge from different actors, builds mutual understanding and provides an improved basis for building agreements, transformations and changes. This is illustrated in the outcomes of the climate change adaptation strategy approved in December 2014 by the Metropolitan Municipality of Lima, where baselines have been adapted against serious droughts and intensive rainfalls in critical periods.

However, the discussion about the water crisis as a governance crisis is reflected in the institutional fragmentation characteristic of Lima (Bakker, 2010; Castro, 2007). Such fragmentation makes exchanging information and knowledge across the boundaries of various institutions, and research and policy-building projects more difficult. Although mapping produces new types of knowledge, it is necessary to continuously ensure that it is incorporated into baselines for policy-making and implementation for this inclusion to gain wider acceptance (Zwarteveen et al., 2014).

[145] Inclusive spaces are spaces of trust where mutual understanding is sought to encourage key actors to fully participate in building consensus on agreements, reduce conflicts among the group, and receive/welcome new sources of knowledge.

Finally, the discourses of water as a human right and socio-ecological good have gained wider recognition in the Lima water governance configuration and been utilised by SUNASS, some experts from SEDAPAL and the Housing Ministry. However, the dominant discourse of 'water as an economic good' still influences SEDAPAL's water distribution (those who pay more get more water). The exception is the case of powerful water users (such as the mining sector and other industries), who consume higher amounts of water but pay much less than urban users. This prevents reducing water consumption and limits the effectiveness of eco-efficiency via market incentives alone.

The processes explained above have contributed to a more comprehensive understanding of water-related inequalities, vulnerabilities and risks, across the boundaries of local governance networks. They have also raised awareness and increased knowledge among actors in Lima's water configuration on the different discourses and ways of thinking when dealing with the uncertainties of future stresses and shocks. Approving the city's Climate Change Strategy has received a clear contribution from these processes. It has also provided opportunities to reconcile or harmonise different water discourses and evaluate how far they interconnect with the metropolitan urban development approaches, which determine the capacities to build up agreements and may contribute to reconfiguring water governance.

Chapter 6. Knowledge building in adaptation management: *Concertación* processes in transforming Lima water and climate change governance

Liliana Miranda Sara and Isa Baud[146]

6.1. Abstract

In recent years, three processes have run parallel analyzing the consequences of plausible climate change scenarios for urban water governance in Lima. The first was led by a German-financed research programme whose objective was to develop climate change scenarios and water simulation models. The Municipality of Lima Metropolitana initiated the second to develop city development strategies and a climate change adaptation strategy. The Chance2Sustain programme has opened up a discussion on more spatial perspectives in city development and water governance, linking knowledge construction and spatialising scenarios by mapping methods visualising inequities and areas of water-related vulnerabilities. This has made it possible to include community-based knowledge into such scenarios.

Outlining the water-related risks of Lima, the paper examines what contributions processes of socially constructing knowledge make to transitions in metropolitan water governance and climate change adaptation strategies; focusing on the extent to which *concertación* processes include a wider range of actors, discourses and knowledge in metropolitan governance and adaptation strategies, and how these influence shifts in setting priorities in decision-making, which such processes are supposed to incorporate.

Although these processes used *concertación* and social knowledge construction, the actors and kinds of knowledge incorporated differed considerably. Whereas the first example remained largely dominated by professional groups and technical-professional knowledge, the city process and C2S processes include a wider range of actors and community knowledge and practice, moving towards transitions in thinking about adaptive management and knowledge building.

6.2. Knowledge Building, *Concertacion* and Adaptation in Lima

Peru is one of ten countries most vulnerable to climate change[147]. A highly centralised country, its metropolitan cities of Lima (capital) and adjoining Callao contain 32% of the population and generate 45% of the country's GDP and will experience many of the climate change consequences. Climate change scenarios for Lima show high levels of uncertainty, with either prolonged droughts or more variable and intense rainfall, or combinations of both

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[146] This chapter was published as an article: Miranda Sara, L., Baud, I.S.A. (2014) Knowledge-building in adaptation management: concertación processes in transforming Lima water and climate change governance, in: *Environment and Urbanization*. 26:2, 505-524.

[147] Tyndall Centre for Climate Change Research (2004). W Neil Adger, Nick Brooks, Graham Bentham, Maureen Agnew and Siri Eriksen, New Indicators of Vulnerability and Adaptive Capacity. Tyndall Project IT1.11. Technical Report 7. Reino Unido: Tyndal Centre.

by 2025 (Bardossy et al., 2011).[148] The risks for the city in the long-term, associated with extreme events like heavy rainfalls, consist of flooding and mudslides and landslides and a 6% rise in rainfall (affecting neighbourhoods along the river Rimac especially), or more extreme droughts (10% decrease in rainfall and even less water flows), and increasing water scarcity. The existing unequal distribution of water between high- and low-income areas would be exacerbated with price increases and would contribute to the spread of diseases[149].

The lack of rainfall in the city necessitates the sourcing of drinking water supply from the upper Andean Mantaro river basin and wetlands of Junin and Pasco. However, these areas face decreases in potential supplies because of melting glaciers and groundwater extraction (Bardossy et al., 2011).[150] Lima has over 8 million inhabitants according to the latest Census (2007), and 74% of dwellings have water connections. However, water distribution is very uneven, SEDAPAL data indicates an average of 250 litres per person per day, ranging between over 460 litres consumed by high-income area inhabitants to less than 50 litres daily consumed by residents of low-income areas.[151] The costs for people without connections are ten times more per litre than for those with piped water by the water company SEDAPAL, and their consumption is less than 25 litres per person daily. SEDAPAL estimates that saving ten litres per day per person, particularly those with high levels of consumption, would alleviate the situation, making constructions of new dams unnecessary for the short run.

Other sources of vulnerability are the high-density urban fabric in the coastal zone, unstable mountain slopes in low-income areas, and wastewater pollution by industrial and mining activities, 85% of which is dumped in the rivers without further treatment.[152]

In the debate on urban climate change adaptation, adaptive management is increasingly being utilised.[153] Social and organisational learning is essential for system survival, and both planned actions, and responses to shocks not planned for, are necessary. Building up the knowledge involves cycles of learning from experience, adding to codified knowledge, and proposing actions for the future. A major assumption is that strong key actors participation is necessary for building consensual agreements, reducing conflicts, and opening up sources of knowledge not otherwise available[154]. In Peru, *concertación* processes involving a variety of actors have become mandatory in various contexts.[155] Key characteristics of *concertación* are

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[148] Bardossy A, Jochen S, Chamorro Alejandro, 2011. Modelamiento del Clima y Balance hídrico de Lima. Proyecto LiWA- IWS- Universidad de Stuttgart cited in Adaptation Strategy of Lima Diagnostic, Unedited document.

[149] Miranda Sara, L. (in preparation) Climate risk scenarios and the integrated spatial and water management in the metropolitan city of Lima, CEPLAN.

[150] Bardossy A, Jochen S, Chamorro Alejandro, 2011. Modelamiento del Clima y Balance hídrico de Lima. Proyecto LiWA- IWS- Universidad de Stuttgart.

[151] SEDAPAL water consumption data, CENSUS INEI, 2007 and Plan Maestro Optimizado 2009-20030, SEDAPAL. Worked by Miranda Liliana and Karin Pffeffer, Chance2Sustain

[152] SEDAPAL, 2012; water water treatment plants are being planned to reduce the latter problem.

[153] Pelling, M. (2011), Adaptation to Climate Change, Routledge, London and New York, 203 pages.

[154] Healey, P. (2007), Urban Complexity and Spatial Strategies, Routlede, London and New York, 328 pages; Baud, I.S.A., Pfeffer, K., Sydenstricker-Neto, J. and Scott, D. (2011), Developing Participatory Spatial knowledge models in metropolitan governance networks for sustainable development, Chance2Sustain WP 1, 20 pages (EADI.org website); Appadurai, A. (2001), 'Deep democracy, urban governmentality and the horizon of politics', Public Culture, Vol 14, No 1, 21-47; van Buuren, A. (2009), 'Knowledge for Governance, Governance of Knowledge: Inclusive Knowledge Management in Collaborative Governance Processes', International Public Management Journal, Vol 12, No 2, 208-235.

[155] Miranda Sara, L., Hordijk, M., Torres Molinas, R. (2011), Water Governance Key Approaches: an analytical Framework, Chance2Sustain WP4, 23 pages.
Webpage: http://www.chance2sustain.eu/33.0.html

learning-by-doing process combined with the social construction of knowledge. The latter implies the validation (or contestation) of a variety of knowledge by participating actors, and a highly sensitive and complex process of dialogue – negotiation – *concertación* - conflict management and consensus-building (or not). Such processes are cycles, which are never static, but constantly evolving.

However, there are also concerns about factors that influence the extent to which different sources of knowledge are included in urban governance decision-making. These concerns take two broad forms; one involves the power relations in new forms of hybrid network governance, and the other concerns ways of 'mapping' and unravelling embedded knowledge from local communities as counterpoints to expert-led organisational knowledge.[156] Both attempt to integrate 'lived experiences' from practice with planning representations for urban adaptation and development strategies. However, the discourses, actors and experiences they acknowledge are very different. From the perspective of hybrid network governance, the debate is framed around knowledge management, as city governments attempt to combine economic growth measures with better service delivery to citizens, increasing adaptive capacity and transitioning to sustainability in their use of natural resources, water being a strategic example (Hordijk et al., 2014). These discussions usually concentrate on the input of codified or expert knowledge in professional organisations.[157] However, a much greater variety of knowledge and knowledge-producing actors exists whose knowledge needs to be included in designing and implementing urban resilience and transition strategies. This can include knowledge embedded in professional practice at the sectoral level (engineering practices; community workers), the lived experience of local communities and lay science built up through community-based research (Patel et al., 2012; van Ewijk et al., 2009). Mapping of such embedded knowledge requires the inclusion of community-based actors and their representatives, bringing in knowledge from the lived practice they find strategic (Karpouzoglou et al., 2012; Scott et al., 2009).

Decision-making for urban resilience and transition strategies implies knowledge management with multi-scalar perspectives of the territory (local and regional). Framing water risk issues, designing and locating water provision and disaster prevention systems, require tracing and planning processes across space and time. Although mapping techniques on paper or digitally within GIS software are becoming more common instruments for spatialising knowledge, there is still a large divide in their use between planners and engineers on the one hand and the wider actors community on the other, less familiar with such instruments.[158] Similarly, the sources of information and the dimensions included or excluded need to be made explicit to determine whether the priorities of all actors are reflected and whether relevant information and communities are excluded.[159]

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[156]See recent issue of E&U (vol. 24, no.1, 2012) for a special section on community-led mapping; Karpouzouglou, T. and Zimmer, A. (2012) Closing the Gap between 'Expert' and 'Lay' Knowledge in the Governance of Wastewater: Lessons and Reflections from New Delhi for the contrast between government and residents views on urban water provision.

[157] cf. Medema, W. et al. (2008). 'From Premise to practice: A critical assessment of integrated water resources management and adaptive management approaches in the water sector', Ecology and Society, vol. 13, no. 2, article 29.

[158] Baud, I.S.A., Scott, D., Pfeffer, K. and others (2013), Spatial knowledge management in urban local government: e-governance in India, Brazil, South Africa and Peru, C2S WP5 Fieldwork Report, 150 p. http://www.chance2sustain.eu/fileadmin/Website/Dokumente/Dokumente/Publications/pub_2013/C2S_FR_No04_WP5__V3-6__100dpi_.pdf

[159] cf. McCall, M., and Dunn, C. (2012), 'Geo - information tools for participatory spatial planning : fulfilling the criteria for good governance', *Geoforum*, vol. 43, no. 1, 81-94 (McCall et al., 2012); Martinez, J., Pfeffer, K. and van Dijk, T. (2011), 'E-government tools, claimed potentials/unnamed limitations; the case of Kalyan-

Therefore, in defining knowledge building and knowledge management systems generally, we need to include these dimensions: 1) framing and discourses around urban strategies, 2) the variety of actors producing and using knowledge in network governance (and who is excluded), 3) the coalitions and networks formed, including their power relations and contestations, 4) the spatialised knowledge produced and included and 5) the changes in processes and outcomes resulting from the hybrid sources of knowledge being utilised.

In this paper we examine what contributions processes of socially constructing knowledge make to water governance and climate change adaptation strategies towards transition; focusing specifically on the extent to which *concertación* processes allow the inclusion of a wider range of actors, discourses and knowledge in urban governance and adaptation strategies, and how these influence priority setting in decision-making processes. We do this by analyzing inclusive scenario building, which has been a tool for water and climate change adaptation in the Lima metropolitan context since 2008.

The case of water and climate change governance in Lima, Peru, is highly relevant for several reasons. First, water is a scarce resource, which needs to be allocated in a socially just and environmentally sustainable manner. In Lima, acute water scarcity leads to conflicts between urban water provision, generation of energy, ecosystem replenishment and farmer requirements, with climate change already exacerbating the existing situation. Second, *concertación* processes offer possibilities of mutual understanding and consensus-building by including a wider range of actors and various types of knowledge into the discussions and dialogues. These are represented in this paper by a joint German-Peruvian research project called LiWA, which has run since 2008 in Lima and the activities of the Environmental Commission of the Municipality of Lima to develop the Climate Change Adaptation Strategy of Lima. Third, these programs on water and climate change adaptation in Lima have included scenario-building workshops involving different actors. Therefore, this is an excellent case for examining whether and how inclusive processes can reduce conflicts, integrate a variety of knowledge and its spatialisation, enable a deeper understanding of a very complex system such as the water governance system of metropolitan Lima and produce a certain consensus for sustainable water governance in metropolitan cities.

These sections analyse these questions:

- What contributions do participatory processes make in increasing spaces for different actors, and for including varieties of knowledge, and shifting discourses?
- How does the inclusion of different types of knowledge contribute to participatory processes?
- What kind of networks are built up through such participatory processes in terms of trust, exchange of knowledge and joint planning processes?

6.3. Actors, phases and dominant discourses

In this section, we look at the extent to which the joint German-Peruvian LiWA research project contributed to increasing spaces for several kinds of actors over time, what types of

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Dombivili' in *Environment and Urbanization Asia,* vol.2, no 2, 223-234 (Martínez et al., 2011); Van Teeffelen, J. and Baud, I.S.A. (2011), Exercising citizenship: invited and negotiated spaces in grievance redressal systems in Hubli-Dharwad', *Environment and Urbanization Asia*, vol.2, no 2, 169-186 (van Teeffelen & Baud, 2011).

knowledge were included and which discourses became dominant during the phases of the programme. The LiWA project was funded by the Ministry of Research in Germany (within the Future of Megacities programme) with contributions from the partners in Lima and Callao, Peru. This international research project included various knowledge-building processes, particularly the work package for 'Lima water governance 2040' from 2008-2012 (see Annex 2). Among other activities were scenario workshops and roundtables in which the main actors from the metropolitan city and its greater territory participated, which permitted the research team to explore different types of knowledge (expert, codified, contextual embedded) and to identify the dominant discourses that participating actors represented in relation to sustainable development and water governance issues (explicit and implicit)[160].

The LiWA project, initiated in 2008, brought together the para-statal water company SEDAPAL and the LiWA[161] partners, which included German academic institutions,[162] private sector consultants, a Peruvian inter-institutional network called Cities for Life Forum (FORO)[163], the National University of Engineers (UNI) and a Peruvian NGO, FOVIDA, which have been primary stakeholders in proposing processes for dealing with future water governance and climate change adaptation for the city (Annex 1). These initial partners, representing the public sector, civil society, academics and the private sector, were recruited to the programme and participated in all phases of the scenario building, in varying degrees. In later phases of the programme, participation gradually widened to include more community-based organisations and local political representatives who participated voluntarily, but with institutional commitment. As the scenario process progressed from developing a scientific model to dissemination and discussion of the model, the network of actors was expanded further to include a wider range of participants, of whom the Municipality of Lima was an important new partner included.

By 2012, while the LiWA scenario-building process continued, a second process was initiated called the Lima Climate Change Adaptation Strategy process, led by the Climate Change Technical Group of the Environmental Commission of the Municipality of Lima (see Figure 6.2 for a timeline). The members consisted of the environmental team of the Municipality of Lima, the FORO as a technical coordinating agency, and the AVINA foundation [164] as the financial agency.

6.4. LiWA water governance work package research project

The LiWA water governance work package took place in several phases (3) and stages (8), and was characterised by different participation of actors and discourses, each generating different products as you may see in Annex 2.

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[160] The first author of this article also carried out a series of repeat interviews, with nineteen key actors in water governance as part of her PhD work and for another research programme (Chance2Sustain); the results from those discussions were brought into the scenario-building workshops of the LiWA programme.

[161] http://www.lima-water.de/en/index.html

[162] These included German partners with scientific and engineering research backgrounds, such as the ZIRIUS/formerly ZIRN, the only German expert living in Peru (sent by Stuttgart University Institute), the research institute IFAK, which contributed a water and waste water modeling product, the LiWA Tool from Magdeburg University, and the Helmholtz Centre from Leipzig, which was in charge of the economic drivers and water tariff analysis.

[163] Miranda, L. (2004), Cities for Life revisited: capacity-building for urban management in Peru, *Environment and Urbanization*, October; vol. 16, no. 2, pp. 249-262.

[164] Foundations, Leadership for sustainable development http://www.avina.net/eng

During the first 'scientific' phase in 2008-2009 (see Figure 6.2) the LiWA partners, listed above, were the main participants; they consisted of German partners with scientific and engineering research backgrounds, such as the ZIRIUS/formerly ZIRN the only German expert living in Peru, IFAK from Magdeburg, University and the Helmholtz Centre from Leipzig. On the Peruvian side, the partners were the para-statal water company (SEDAPAL), the National University of Engineers (UNI), representatives from the civil society such as the FORO (Cities for Life Forum), and the NGO FOVIDA. Participation was limited to these actors for the first meetings with a few invited experts. The dominant discourse in this period was towards a 'pro-growth' development, and on water as a sector, slowly becoming combined with a discourse of water (with 'water' viewed as an urban sector providing drinking water) as a human right (a pro-poor focus)[165]. The main activities were to determine the water-related climate change drivers as the basis for developing alternative scenarios by constructing the CIB method of evaluation of interdependencies between the drivers and sub drivers[166], with strong participation from the actors. The strong emphasis on the scientific and objective character of the scenario-building method (CIB), from the second to the sixth stage, came from LiWa's German partners (ZIRIUS/ZIRN, IFAK), whereas the Peruvian NGO partners wanted to discuss and build up knowledge on urban issues, privatisation processes, poverty issues, and, particularly, a wider ecosystem and ecological sanitation perspective. The water company was the dominant partner on the Peruvian side.

The main knowledge included was expert, codified academic and technical knowledge, from the disciplines of engineering, architecture, sociology and the professional knowledge of water providers. Each group of actors (private sector, public sector and NGOs) produced their own set of economic, social and political drivers of water and climate change and these were discussed during joint workshops. The results were used as inputs for the final model, with four main scenarios with several configurations, which was developed in Germany by the ZIRIUS/ZIRN team of researchers using a software programme 'Scenario Wizard'[167], based on the cross-impact balance (CIB) analysis, whose internal configuration was not known to the other participants at that stage[168].

The second, transitional phase, was linked to a mid-term review of the project in 2010, in which representatives of reviewing organisations[169] suggested that the project needed to shift slightly from the scientific focus, to also include policy impacts of changing water governance on the city, and the implications of implementing broader water provision for other urban issues. This meant that a city and urban perspective needed to be included in the scenario-building processes. In this phase, although the dominant discourse kept a 'pro-growth' focus (large water infrastructure development) retaining its sector perspective, it finally included a 'water as a human right' approach. Because of the review, a new work package of activities was developed on 'ecological infrastructures in the city' (see Box I).

The main knowledge included remained expert, codified knowledge, but the range of disciplines expanded to include landscape architects, urban planners and geographers. During

[165] The characterisation refers to the model built up in Miranda Sara, Hordijk et al. 2011, *Water Governance Key Approaches: an analytical framework,* Chance2Sustain, EADI. See footnote 7.
[166] http://www.cross-impact.de/english/CIB_e.htm
[167] http://www.cross-impact.de/english/CIB_e_ScW.htm
[168] After the scenarios were developed a training workshop on how to use the software for the LiWA partners was developed, then the story lines started to be developed first with ZIRIUS team contributions and then edited by LiWA Peruvian partners.
[169] These included the Asian Development Bank, Un-Habitat and World Bank, among others

this phase, the scenario workshops included many more participants to discuss and verify the drivers identified during the first phase with a wider network of people.

The third phase of the project, which has taken place since 2011, is characterised by a shift in the political context in Peru, with a new Peruvian president and the new mayor of Lima, both of whom provide more open policy spaces for sharing the knowledge produced in the partnership between the water company and the scientific partners. This has made it possible for NGOs to participate more fully and help to develop the focus on producing policy products for the LiWA programme. During this phase, a countrywide meeting with community water managers in Peru was held, with several NGO networks focused on water management (organised by the Safe Water network with AVINA support). The results were brought into the LiWA programme, shifting the focus to more policy-oriented products.

Box 1 Designing for a city out of water: Lima Ecological Infrastructure Strategy

To develop a sense of a new water culture for Lima, a new approach to infrastructure design can act as a catalyst for landscape transformation. The aim of the 'Lima Ecological Infrastructure Strategy' (LEIS), developed as part of the LiWA Integrated Urban Planning work package, is to provide guiding principles for open space design to proactively contribute to improving and protecting the urban water cycle. This approach shifts the focus from the current practice of 'image-based' open space design to 'performance-based' open space design. It no longer considers urban open space an expensive luxury but one that needs to save and purify water, treat wastewater and recycle nutrients or even harvest water. Urban open spaces are seen in connection with remaining spaces of agricultural farmland, archaeological heritage and natural ecosystems e.g. rivers, wetlands and marshes (*lomas)*. These landscape elements should create an interlinked network, serving as a framework for developing the urban structure by providing essential infrastructural services, protecting ecological and cultural heritage and enabling recreational experience.

ILPE uses a geographical information system (GIS) to store, analyse and synthesise layers of environmental, infrastructural and social data from different sources. This information should be available to all actors responsible for water management and urban planning in order to integrate and adapt their actual and future planning. To become applicable, the strategy needs to integrate multiple scales. At the metropolitan level, principles for Ecological Infrastructure are defined, harmonised and integrated with the Regional Concerted Development Plan. Those principles aim to convert into policies that integrate future urban planning and water management at macro, meso- and micro scale.

Locally, projects for prototypical water-sensitive solutions within different existing 'hydro-urban units' are developed. Water-related problems and opportunities vary from place to place due to different natural and urban contexts within the watershed. Site-specific design strategies show how hard and soft engineering can be combined. Functional and aesthetic aspects are considered equal to social aspects, management and institutional frameworks.

Towards a water-sensitive future for Lima: The goal of all projects is not just to minimise impact but also to develop regenerative and productive hydro-urban landscapes continually renewing ecosystem functioning. A system of such water-sensitive open spaces should create an innovative urban ecological infrastructure for Lima´s future. The project demonstrates opportunities for radical rethinking of landscapes in an arid city by developing new landscape typologies that save, produce, purify and distribute water in its different forms.

References

Work package 'Integrated urban planning strategies and planning tools'. Project team Stuttgart: Prof. Antje Stokman, Dr. Bernd Eisenberg, Rossana Poblet, Eva Nemcova (Institute of Landscape Planning and Ecology, Stuttgart University)

Project team Lima: Liliana Miranda, Linda Zilbert, Rommy Torres (Interinstitucional network, FCPV), Juan Espinola, Luis Jara, Claudia Santisteban (Instituto Metropolitano de Planificación), Julio Moscoso (Consultant), Prof. Rosa Miglio (Universidad Nacional Agraria La Molina), Jochen Beerhalter (Oficina de Medio Ambiente del Ministerio de Vivienda, Construcción y Saneamiento, MVCS, OMA)

Simultaneously the LiWA partners continued the scenario building process and the workshops for validating the indicators per driver as part of the description of each driver. The new work package focusing on the urban ecological infrastructure strategy had shifted the dominant discourse to a more urban and pro-green focus and led to the Metropolitan Planning Institute (IMP) from the Metropolitan Municipality of Lima (MML) coming in as new partner into the project. The main Peruvian partner – the water company – was not much for these shifts at that moment, probably because of fears related to the political context of national elections and the consequent changes in people in a high-level position in SEDAPAL, which happened.[170] This phase also included the first water and climate change roundtable in Lima and Callao, in which politicians, private sector, international agencies, civic society organisations, community leaders, MML, the Chance2Sustain Programme and the recently created National Water Authority participated.

Simultaneously in 2011, parallel activities were taking place with the FORO as a facilitator and technical coordinator with other actors, such as the Environmental Team and the IMP of the Lima Municipality, the EU-funded programme Chance2Sustain, and ILPE[171]. Several workshops were held, focusing on an adaptation to climate change agenda for Lima city and urban development strategies with integrated water management. A broader network of MML, private sector actors, the LiWA partners, government and the inter-institutional FORO network started to be created. The dominant discourse shifted towards 'water as a right for all living beings', which combines a focus on ecosystem approaches with water as basic human need with a 'pro-green' development discourse. The main knowledge continued to be expert, codified knowledge but started also to include more multi-disciplinary and contextual embedded knowledge from practice through the series of meetings held with practitioners.

In 2012-2013, the final stages (the seventh and eighth) of the third phase of preparing 'policy products' of the LiWA water and Climate Change Programme started, in which three other roundtables for developing adaptation measures based on the climate change scenarios prepared were discussed in terms of policy implications and implementation (Water and Climate Action Plan of Lima and Callao signed in April 2013). Each LiWA partner designed measures, with prioritisation of measures to indicate methods of implementation (FORO developed 3 out of 12 measures). The partners in these activities were the German members ZIRIUS/ILPE/IFAK and the Peruvian partners, with gradually less prominent participation of SEDAPAL. During these roundtables, the main knowledge included was expert, codified and some contextual-embedded knowledge from practice through the Municipality and the new representatives of the water company (which changed due to the newly elected central government). The FORO suggested that an additional relevant goal would be to develop an Action Plan as a final product from the programme, which was agreed upon by various institutions and subsequently developed[172].

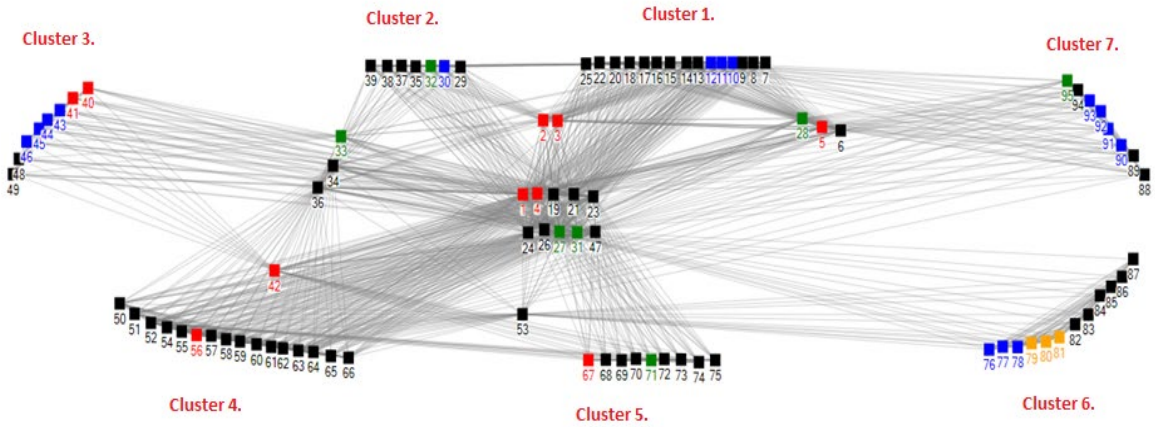
6.5. MML and the Climate Change Adaptation Strategy

Since early 2012, the Metropolitan Municipality of Lima's (MML) environmental team developed a new initiative to prepare the climate change adaptation strategy, simultaneously

[170] However, against every prediction the new President Humala and his Congress have systematically rejected any participation from the Municipalities of Lima and Callao in the board of directors of SEDAPAL until 2013.
[171] http://www.ilpoe.uni-stuttgart.de/institut
[172] SEDAPAL, MML, SUNASS, FORO, FOVIDA, UNI and SENAMHI.

with the final phase of LiWA. It established the Metropolitan Environmental Commission, bringing together representatives from regional, municipal and district governments and the business sector, academics, citizen movements and NGO representatives. Figure 6.1. shows a social network analysis done on the Environmental Commission members; the network shows that the Metropolitan Municipality of Lima, regional governments, with the Ministries and universities, are central actors, with the water company, the local water authorities (ALA)[173] (Chillon, Rimac and Lurin), the private sector and civil society being less centrally involved as members of the Technical Groups.

Figure 6.1: Environmental Commission of MM Lima: membership networks in technical groups for CC Adaptation Strategy



In the MML network, Technical Working groups were set up for six priority topics (and a 7th group for coordination), including climate change, for developing strategies and action plans. This technical working group was made responsible for participating in the development and future implementation of the adaptation strategy, and additional experts were included, e.g. from international research projects, UNDP and the Ministry of the Environment.

The technical working group on climate change consisted of MML's internal environmental team, and the inter-institutional network FORO. Utilising the work done so far by the LiWA project and the Chance2Sustain EU-research project, with information coming from the

[173] Local Authority of Water, created as part of the National System of Integrated Management of Hydrological Resources led by the National Authority of Water, (ANA).

National Authority of Water, the IPCC Peruvian member, the meteorological institute (SENAMHI) and expertise coming from the technical group members, several activities were held. These included an expert workshop with six Peruvian 'climate experts' and central government representatives to build an agreement defining three plausible scenarios for 2025; the very dry one, the incidental but more frequent heavy rain one, and a combination of both (a combination of dryer trends combined with incidental heavy rainy events/seasons). Further activities included ALA regional workshops with municipal officers and interviews such as with the popular movement of those without water in Peru. These initiatives were not welcomed by all LiWA partners (e.g. the water company), who initially resisted the request to allow the use of their data within the new context.

The elaboration of the strategy was eventually based primarily on contributions made by NGOs, a Peruvian IPCC scientific member and international research projects. In addition, the Swiss AVINA Foundation provided funds for an expert team from the FORO, which finalised the adaptation strategy in August 2012. The environmental team of MML has started final editing of the Strategy and internal consultations as preparation for publication. Submission to Lima's City Council for its adoption is planned for the second semester of 2013.

The knowledge in the activities in this parallel phase consisted mainly of expert, codified, and contextual embedded knowledge from professionals in a variety of disciplines (mainly engineers, architects, urban planners, biologists, geographers, sociologists, meteorologists, communicators, geologist, agricultural engineers and scientist from IPCC), but also political leaders, private sector and academics. Direct inputs of community knowledge were not strong (but mediated through NGO networks FOVIDA, the Citizens Movement for Climate Change, the FORO and municipal representatives). Activities from the Chance2Sustain EU-programme included community-based studies in three locations in and outside the city (Huascaocha, Tamboraque highlands and the left side of the Rimac River in the centre of Lima - MIRR) exploring perceptions of water and climate change vulnerabilities at community level whose main conclusions were brought into the discussions.

The core partners of the LiWA project and its *concertación* processes show that the dominant voices in that process are those of engineers, academics and the water company, with the inter-institutional network FORO maintaining a facilitator role, supporting governance and inter-institutional connections. Although the FORO gradually played a stronger role, it remained weak in comparison with SEDAPAL or other governmental entities (for ZIRIUS civic society organisations are weaker even until now). Community-based organisations and representatives from Lima Municipality were consulted once the basic model, its main dimensions and the scenarios had been established, so those stakeholders could not add additional dimensions and issues. The water company held a decisive position, deciding on what information should be shared with the other Peruvian partners. The German academics had privileged access to internal information from the water company for their technical analysis, whose results were not shared until late, revealing structures of (dis)trust inside the institution slowly being reduced by the current administration. The dominant discourses during the process leaned heavily towards a scientific, analytical approach based on water as a human right and as urban (drinking water) sector, which shifted, thanks to the suggestion from mid-term reviewers and Peruvian partners to a city perspective in which water is part of an urban ecological infrastructure. Although large areas of consensus were built up, the remaining focus on scientific-academic work among the German partners makes linkages to policy and implementation complex, so that now the Municipality of Lima is working with Peruvian partners to develop in that direction.

With the parallel process with the environmental team of MML, MML information was shared more easily with the partners engaged for preparing the strategy. The climate change technical group was informed and consulted regularly and strategies discussed with participants in several workshops[174]. The LiWA partners based in Peru participated in this process. Although the adaptation strategy for climate change has not been approved yet by the councillors, the final document has been shared by mail, contributions have been received and internal discussions in MML have directly contributed the text, so a basic consensus is already built. The publication of the document was planned for the end of 2013.

6.6. Constructing knowledge within *concertación* processes: generation, exchange, contestation and use

In this section, we turn to the more specific question of how knowledge was constructed within the network of organisations during the different phases of the *concertación* processes, in both the LiWA research programme and the MML-led process.

In the LiWA research programme, key discourses in water governance were identified among the actors in the Lima water governance network, based on workshop discussions and individual interviews[175]. The main discourses include a view on **water** as an 'economic good', a 'human right', a 'right of nature or all beings (human/ecosystem)' and/or '(drinking water) sector'; just as actors in the *concertación* processes also identified **development as** 'pro-growth', 'pro-poor', 'pro-life/green' and 'sectoral (mainly pro-large water infrastructure investments)' discourses.

With Lima, government actors, particularly from the central government, often apply a dominant 'pro-growth' combined with a 'pro-sector' discourse. However, the metropolitan government and its related institutions, and civil society organisations, are gradually taking a 'pro-poor' and 'pro-life/green' focus. The water company takes a combined pro-poor and drinking water sector approach.

The *concertación* process developed within the LiWA research programme followed a course in which each participating actor analysed from their viewpoint, identifying opportunities for the harmonisation or reconciliation with other actors' views (moving from dialogue via negotiation, conflict management, consultation to consensus building). During this process, knowledge of existing discourses and practices was built up, exchanged, and areas of conflict and cooperation identified and managed.

During the first phase between 2008-2009, knowledge produced identified the main drivers of climate change, determined in the series of workshops held with different partners. Some thirteen drivers were identified by the NGOs, public sector and private sector and grouped into these five types:

- ecology (source areas and aquifers),
- governance– (institutions and their authority),
- economic factors (internalisation of costs),

[174] Participants were from district municipalities, central government entities, private sector, citizen organisations, academics and civic society organisations with a more 'green' development approach where LiWA/ZIRIUS was a participant on par with the rest.
[175] see Miranda Sara et al. (2011)

- planning (urban form, including land use plans and issue of increasing informal growth), and
- education (efficiency in using water sources, and sensitisation on water issues) (ppt LiWA workshop 06-10-2011).

The drivers and sub-drivers were discussed extensively in small groups in terms of their prioritisation, directions of change and internal connections. The complexity of the drivers became clear during this process. Through the discussions, contextual-embedded knowledge from sectoral practice was included in developing the drivers.

The analytical framework emerging from the discussions combined the drivers the participants assigned to them, although they differed in their ranking of them. Ecological issues concerned the protection of water sources and integrated water resource management (IWRM), which were considered very important by all groups of participants.[176] Economic issues raised concerning sustainable water rates and spill-over effects of water provision were considered less important by civil society actors than by public and private sector participants. Governance issues raised were strengthening of leadership, regulation, resolution of conflicts, dialogues and alliances, considered very important by the public sector and civil society participants, and less so by private sector participants (such as the National Society of Industries). Planning issues concerning land use planning and better control of unplanned growth were considered important by public and private sector participants, whereas civil society participants gave this little priority. Efficiency in the water sector concerned the reduction of water losses, sustainable sanitation, and the re-use of wastewater; this was considered important by civil society participants, and somewhat important by the other two sets of actors. Finally, increasing knowledge through sensitisation on water issues was only considered important by the public sector.

During the scenario workshops, there was continuous discussion on the drivers, their indicators and their relative priorities, with some strong disagreements and tensions. For instance, defining poverty as inequality as put forward by the inter-institutional network or reducing poverty by widening participation were issues on which there was disagreement. IFAK, a German LiWA partner in charge of the LiWA Tool needed numbers on poverty and socio-economic classifications for developing the simulation tool for drinking water and wastewater flows (because each socio-economic class consumes different amounts of water in the city). When disagreements became too heated the topic was shelved for some time and was taken up again after individual mediations, but not necessarily solved. The combination of the drivers and scenarios with the LiWA Tool has been finalised, but so far, it is unclear how average figures for water consumption in each socio-economic class (provided by SEDAPAL) have been applied in the LiWA Tool.

In stage 3 and 4 (see Annex 2) the partners each took up specific drivers on which to collect background information and provide input into subsequent workshops. The inter-institutional

[176] Law N° 29338, General Law of Integrated Hydrological Resource Management of Peru -IRGS, Integrated, creating a concertative councils to manage water for all purposes (agricultural, population, mines, industries) at Central, Regional and river basin level, but lacking the participation of consumers at household level (urban or rural).
Law Nº 28245: Establishing the national environmental management system of Peru - SNGA, Based on a set of environmental management commissions and their technical groups, where governmental bodies at Central, Regional and Local level, as well as sector ministries, civic society, private sector and academics have mandates and/or commitments on environmental issues. These laws made *concertación* processes mandatory.

network FORO worked on planning and governance drivers, sourcing knowledge from planning documents and interviews, and validating this knowledge through meetings with local experts. Descriptors and sub-descriptors and indicators were written up, and results brought into the LiWA meetings. The water company worked on water management, water flow, sourcing internal knowledge and, with a German university researcher, on modeling river water flows in the Andes; one German university research centre worked on economic drivers in relation to water with SUNASS[177] using information provided by the water company and another German research centre worked on education drivers with the Peruvian NGO FOVIDA.

Through successive workshop discussions, additional drivers of water and climate change were identified, particularly as sub-drivers; the option of privatising the parastatal water company, and the urban form, wastewater treatment and water re-use as drivers. Although the effects of possible privatisation of drinking water provision remained contested as sub-driver, other drivers identified were accepted finally by all participants. So, later thanks to the discussions and exchange, 12 drivers were defined and agreed upon:

- Form of Government
- Water Company Management
- Water Tariffs
- Population Growth
- Urban Poverty
- Water Consumption
- Catchment Management
- Urban Form
- Water Deficit
- Waste Water Treatment and Reuse
- Water Infrastructure
- Climate Change

(from ppt León, C., 24-26.05.2011)

For each driver, a description and sub-description (or sub-driver) were developed, with plausible scenarios for 2040. For instance, in the case of Urban Form 2 sub-drivers were defined: 1) Urban structure with sufficient green spaces and 2) urban structure without sufficient green spaces.

Information exchange among partners was uneven until the mid-term review of 2010. Internal information from the water company was only provided to the German academic partners, for scientific analysis, under the strict provision it would not be passed on to other partners in the *concertación* process; all LiWA partners (German and Peruvians) had to sign a confidentiality clause as a contractual condition before LiWA started. The German partners took the contextual-embedded information on drivers developed during successive workshops and internal technical information from the water company and developed scenarios as a team in Germany through their cross-impact balance and the Scenario Wizard software programme, which built up scenarios based on different combinations of linkages between the drivers. The

[177] National water regulatory entity of Perú: http://www.sunass.gob.pe

ZIRIUS coordinator carried out the scenario analysis and chose the four most 'consistent' scenarios based on the results and two other variations (six in total).

In October 2010 the mid-term reviewers brought in the city and urban perspective into the discussion, focusing attention on what was happening to the city and the influence of the existing and plausible urban future. These reviewers brought in primarily expert knowledge based on technical academic backgrounds and their experience in practice over a long period. The resulting redesign of the LiWA research project included an extra work-package focusing on urban form, which provided a spatial perspective for the first time, and much more contextually-embedded knowledge from urban practice.

In the third LiWA programme phase of 'policy-related products' from 2011 onwards, the German landscape architecture institute (ILPOE), the Metropolitan Institute of Planning – IMP - from the Municipality of Lima, the Peruvian inter-institutional network FORO and recently, also the environmental team of MML developed the new work package within the LiWA project, focusing on the contributions for an ecological infrastructure strategy could make to Lima's water and climate change adaptation strategy. Making use of the FORO's participation in the EU-funded research programme (Chance2Sustain), the two groups utilised expert, codified knowledge and their own contextually-embedded experience from working with a variety of practising actors to prepare background reports. An explicitly spatial perspective on water and climate change management emerged through the discussions within the Chance2Sustain research programme, and various spatial mapping techniques visualised neighbourhood vulnerability and levels of water accessibility within Lima. However, this remains a separate strand of thinking, with possibilities of being included in the MML Climate Change Adaptation Strategy initiative.

In the LiWA research project discussions on the scenarios developed have been concluded in Lima. Until now, the water company has not formally recognised the six scenarios derived from the simulation analysis and is using a few drivers developed within the programme to do its future planning process. IFAK, the German LiWA general coordinator have developed their simulation tool, the LiWA Tool, and have finalised and combined it with the scenarios developed for designing measures as a part plan which was proposed and signed in March 2013.

When the MML Climate Change (CC) Adaptation Strategy initiative started, conversations with the departments of the MML showed that a variety of discourses on 'city visions' as spatial discourses existed, affecting on water governance views. For the planning institute IMP, the natural environment surrounding the city (agricultural areas, water aquifers) are not central concerns, but subordinate issues. The housing team of the MML had a 'pro-poor' discourse, developing a poverty map for all of Lima, focusing on housing for the poor, identifying areas of extreme poverty and vulnerability, particularly in the hilly areas surrounding the city. The environmental team of MML built up an ecological structure map, showing the landscape units and ecologically sensitive areas in the city (coastal Lomas, the coast, rivers, deserts and mountains). The first two 'city visions' have been formally endorsed by the councillors, but the ecological structure map is still pending. The Ecological Structure map was not approved, only the Ecological Structure classification was formally acknowledged by the end of 2014.

The MML CC Adaptation Strategy initiative also utilised much of the LiWA material and built up knowledge for developing its discussions and the strategy document. The technical group on Climate Change used only three drivers to develop its own set of climate scenarios;

the drivers included population growth, water flow availability, and climate change issues (e.g. temperature, infrastructure vulnerability not only related to water), which were laid down in the analysis for the Lima CC Adaptation Strategy (2012).

At the beginning of this period (2012), community-based information was brought into the Technical Group discussions, through their member NGOs, FOVIDA and the Safe Water Network, which held several community water management workshops[178]. These brought in contextually-embedded knowledge on local forms of water management in areas without official water provision (or insufficient provision). These include the role of community provision of water in low-income neighbourhoods (irrigation and drinking water), and small-scale water channelling initiatives carried out in many local communities, working with international NGOs. The technology used is simple, sourced from practical experience among local communities (cultural knowledge on the upper river basin on how to create a network of small water channels and lagoons to 'harvest' water, and stabilisation of soil to avoid mudslides). This is also done in Lima on the riverbanks, especially in the settlements built up by communities themselves.

The knowledge produced during consultations on community-based practices and knowledge derived from such practices, and knowledge developed in the research programmes, combined to allow the Technical Group to achieve consensus and write up a Climate Change Adaptation Strategy for Lima in record time by 2013 (in less than one year). The consultations with councillors and in the Municipality internally, add political knowledge to the mix to provide a final document, which can be accepted for implementation.

6.7. Conclusions

In the final section, we draw out some conclusions from the discussion above.

Our first question concerned the contributions participatory processes can make in increasing spaces for different stakeholders (including varieties of knowledge, and shifting discourses). We can see that various 'spaces' have been created; both through international research programmes bringing in new actors and building up networks with Peruvian partners (LiWA; Chance2Sustain) and through even more new Peruvian laws providing mandates for new water governance and environmental policy processes, in which *concertación* processes have become mandatory (e.g. MML Environmental Commission and CC Technical Group). The German-led international LiWA research project combined private and public sector actors, with mainly technical academic networks; opening up to discourses on water governance wider considering ecosystem issues, proved difficult, and the 'products' produced remain academic, with little space for products that can be applied in practice although they have generated attention and interest.

In the MML initiative, the legal and regulatory frameworks which historically surrounded a highly centralised government led key metropolitan city actors to work within a sector-based approach to water governance, with no focus on integrating key issues from different discourses on water governance or metropolitan city development. The relatively new laws have changed this pattern and opened up to a larger network of actors, including NGOs, citizen organisations, community-based groups, experts with various backgrounds, and political representatives. Such inter-institutional coordination and *concertación* have emerged

[178] Safe Water Network conference with more than 100 community water managers (Safe Water Network, FOVIDA, FORO, WB, AVINA, LiWA).

and work on a permanent basis. These provide a basic coalition for moving towards transitions to adaptive capacity.

Our second question concerned the different knowledges included in *concertación* processes, and how they contribute to participatory processes. In the German-led research processes, knowledge generation was done by different combinations of partners, with some remaining in fairly closed groups (working with internal company information, technical exchanges, simulation) and others working in wider networks with a variety of methods to elicit knowledge (workshops, focus groups, expert and community interviews) and develop more integrated discourses on water governance. Discussions, conflicts, and consensus-building were an integral part of the knowledge-building processes. The discourses held by the different participants remained fairly close to their origins, not travelling widely within the network, with new dimensions being accepted only after long discussions, or outside persuasion. The focus remained that of a 'water as sector' perspective, with urban and ecological issues and poverty and population growth issues added in. A transectoral and multiscalar integrated approach to the needs of the surrounding territory and the city would be desirable, but the refusal of the SEDAPAL water company to include the Municipalities of Lima and Callao into their management decisions remains a strong political barrier.

In the MML strategy initiative, the discourses encountered in the discussions also showed a wide range from sectoral to an ecosystem approach, but they are being integrated through discussions and meetings within the network. This initiative does build on the LiWA processes which have built up networks of actors across sectoral divides, so the process has not started from scratch; it is also supported by legal frameworks providing strong mandates for integration. Because several participants in the LiWA processes also brought in their knowledge in the MML initiative, knowledge travelled more widely than before. Finally, it has given scope to include contextually-embedded knowledge from local communities (water management in practice). The Chance2Sustain programme has also opened up a discussion on more spatial perspectives in city development and water governance, experimenting with mapping methods, visualising inequities, and indicating areas of vulnerabilities (Miranda et al. 2014).

Our third question concerned what kind of networks such *concertación* processes build up in terms of trust, exchange of knowledge and joint planning processes. Is it possible to build up a hybrid, multi-level network across different stakeholders, or is there a pattern with a central, nodal agency and other stakeholders around it (hub-and-spoke network)? The LiWA *concertación* processes were fairly independent of local government institutions and therefore could resist efforts to include a wider range of actors and new discourses. The water company was a dominant stakeholder in the network and prevented exchanges of knowledge with the wider group of participants, a situation that only changed and softened, slowly opening doors for exchanges after the new central government came into power. The MML initiative combined a legal mandate with a wider variety of participants in their form of *concertación*, making it possible to bring in community contextually-embedded knowledge and acknowledge it. This suggests that knowledge travels more easily in hybrid networks, where mandates and political will provide support.

The main conclusion from the discussion of these *concertación* processes is that actors can build up agreements for collaborative action over time, with diverse water and development discourses and different territorial and city visions and bringing in knowledge from different spatial scale levels. Such processes provide inputs for scenario building within cities towards future forms of water and climate change adaptations. However, such processes by necessity

include strong discussions, conflicts and recognition of the other's discourses and perspectives, and require inclusion of contextually-embedded knowledge and expert codified knowledge, to build up city scenarios capable of 'seeing' what might happen where when conditions change towards the future and moving towards transition. They do require contexts in which democratic and decentralised institutional frameworks exist, providing strong mandates and political will supporting such processes, so the views of the poor, vulnerable and excluded can make themselves heard.

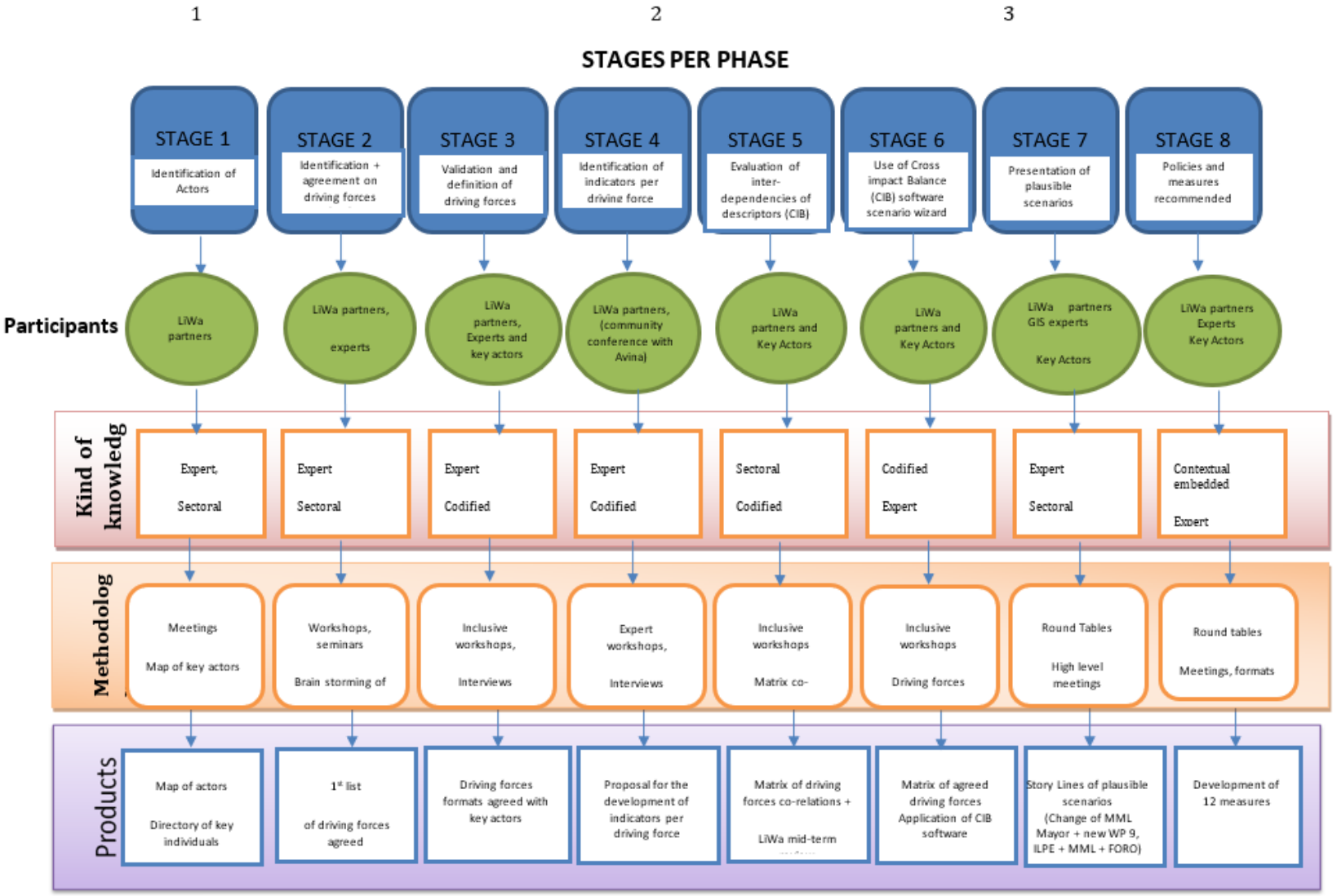
6.8. Annexe 1

LiWA partners:

- Ifak - Institut für Automation und Kommunikation e.V. Magdeburg (General Co-ordinator)
- ZIRIUS (formerly ZIRN) - Stuttgart Research Centre for Interdisciplinary Risk and Innovation Studies, University of Stuttgart, (Co-ordinator Peru)
- Institute for Modelling Hydraulic and Environmental Systems, Department of Hydrology and Geohydrology, University of Stuttgart
- Institute of Landscape Planning and Ecology, Faculty of Architecture and Urban Planning, University of Stuttgart
- SEDAPAL, Servicio de Agua Potable y Alcantarillado de Lima, Perú
- Helmholtz Centre for Environmental Research (UFZ), Department of Economics, Leipzig
- Foro Ciudades para la Vida (FORO), Lima, Perú
- Ostfalia Hochschule für Angewandte Wissenschaften, Campus Suderburg
- Universidad Nacional de Ingeniería, Lima, Perú
- FOVIDA - Fomento de la Vida, Lima, Perú
- Dr. Scholz & Dalchow GmbH (private consultants)

6.9. Annex 2.

Annex 2



[1]Based on graphic done by Rommy Torres for the first version of our WP 4 Methodological Guide, C2S, 2011

Chapter 7. Risk perception: the social construction of spatial knowledge around climate change-related scenarios of drought and heavy rain events in Lima[179]

Liliana Miranda, Shazade Jameson, Karin Pfeffer, Isa Baud

Abstract

Lima's environmental sustainability is threatened by increasing water scarcity, heavy rain events and limited attention towards water vulnerability and climate change scenarios. In this paper, we examine how knowledge construction and risk perception on water-related disaster risks and vulnerabilities affect decision-making and implementation in urban governance networks, specifically looking at some reasons behind high levels of risk tolerance and the lack of decision-making initiatives for putting in place adaptation and/or preventive measures.

New forms of metropolitan governance have constructed spatial knowledge about water-related vulnerabilities using inclusive scenario-building processes. These processes unpack complexities, uncertainties and spatial inequalities in water governance, making them visible by mapping and spatial representations as strategic instruments for social and policy learning.

This article uses two case studies for analysis which either already have or can become disasters (scenario-building). The first case study concerns the long-term plausible scenario of water scarcity and droughts analysing population growth rates, water distribution and consumption through the Chance2Sustain research project and presenting spatial representations. The maps were used to define possible spatial intervention priorities to deal with future water vulnerabilities in Lima. The second case study refers to short-term extreme weather events that already manifested themselves as mudslides and floods as a result of El Niño in eastern Lima, Chosica. We investigate the first case study at the metropolitan city scale and the second at the scale of vulnerable communities. The cases illustrate iterative spatial knowledge construction—in which processes of risk prioritisation, normalisation and tolerance occur—and the resulting [in-]action by a variety of actors.

The methodology for this project used collective and iterative mapping processes, applying technical, organisational and geographical knowledge from a variety of governance, experts and practitioner networks in Lima. The main outcome is social learning derived from bringing together different kinds of knowledge and integrating several dimensions of risk through spatial representations. This social learning has raised awareness, increased capacities for dealing with uncertainty and contributed to the approved Metropolitan Climate Change Adaptation Strategy, not yet implemented by the Lima Municipality.

The main conclusions are two. First, spatial planning is a political process, in which knowledge is contested—or, even when acknowledged, the knowledge does not necessarily steer decision-making processes by local communities, authorities and private institutions. Second, existing models linking knowledge construction to risk framing, risk tolerance and how such framing and tolerance influence decision-making processes and actions to prevent disaster may ignore the issues of risk tolerance through normalisation and prioritisation at their peril.

[179] This chapter was published as Miranda Sara, L. et al. (2016), Risk Perception: the social construction of knowledge around climate change-related scenarios in Lima, *Habitat International*. 53: 1-14.

7.1. Introduction

Recent global reports point to the importance of both creating and using knowledge about vulnerabilities, climate adaptation and disaster risk reduction, as well as identifying and strengthening governance processes. The latest IPCC report (2014a) highlights the need to link climate change, risk reduction and socio-economic development, adding that ending poverty and stabilising the climate are the two great challenges of the century. With the potentially greater effects of climate change already an obstacle to poverty reduction, the IPCC chapter on cities underlines how the people hardest hit[180] will be those living in informal settlements in low- and middle-income countries, where greater and more vulnerable agglomerations continue to grow (see also UCCRN (2015a)). The Report also stresses the importance of building resilience and enabling sustainable development in support of climate change adaption. The UNISDR Sendai Conference (March 2015), itself coming from a Disaster Risk Reduction (DRR) perspective, also outlines the connections between understanding risks, governing them, preventing them by investing in resilience measures and 'building back better' when disasters have struck.

The water-related vulnerabilities of cities are related to existing socio-economic inequalities, as well as environmental phenomena stemming from climate change. Vulnerabilities concern unsafe areas due to environmental risks, such as floods or mudslides, along with lack of access to higher quality living conditions (safe housing, clean drinking water, sanitation, etc.) (cf. *Environment and Urbanization* 2015: vol. 27, no.2). Such conditions are exacerbated by the expected effects of climate change, including the El Niño System Oscillation (ENSO), which is set to change water temperatures, rainfall patterns, water currents and fish stock availability in the coming Peruvian summer ("Floods in Peru are just the latest blow to its economy," 2017; NOAA, 2015; WMO, 2015) [181].

How knowledge about vulnerabilities and risks is integrated and combined with preventive measures is a political process. Both the IPCC and Sendai reports presume that linking knowledge and governance processes will occur, without indicating the possibility of tension and conflicts, which can prevent the acceptance of adaptation measures and the concomitant investments required. However, existing situations of climate change denial and the lack of preparedness for dealing with disasters across multiple scale levels globally show that even when better knowledge is available about risks, other issues prevent governments, private sector and communities from implementing stronger adaptive or preventive actions.

Earlier research showed that knowledge is socially constructed by the interaction between different social groups, such as communities, experts, governments and companies over time; spatialising such knowledge makes visible concentrations of risks and inequalities, and scenario-based maps on vulnerabilities indicate likely dynamics over time (Miranda Sara, 2004). Combining the focus on knowledge about water-related risks and the extent to which such knowledge is embedded in governance processes provides a better understanding of how and why knowledge building about potential disasters is not always sufficiently recognised and given priority (Miranda Sara et al., 2014a). For example, the difficulties for flood management knowledge to 'travel' across institutional boundaries have also been examined in the case of Chennai, India (Jameson et al., 2016).

In this paper, we examine how knowledge construction on water-related disaster risks and vulnerabilities affects decision-making and implementation in urban governance networks, specifically looking at some reasons behind high levels of risk tolerance and the lack of decision-making initiatives in putting preventive measures in place. We understand risk

[180] Such as higher temperatures, heat stress, water insecurity or extreme weather events affecting a higher number of people exposed to these events, in particular urban communities.
[181] http://www.un.org/apps/news/story.asp?NewsID=52570#.Vkt8QHYve1s, visited 17.11.2015.

tolerance to be the combined result of individual and social processes of risk prioritisation and normalisation.

Our first question examines the perceptions of the actors concerned. People in local communities have a wide diversity of risk perceptions and risk tolerance, which leads to different risk reduction strategies (Karpouzoglou et al., 2012; van Voorst, 2015). This diversity alerts us to the second question of how specific risks are prioritised and/or normalised within the socio-economic or physical context where water-related vulnerabilities may not be the worst expected situation in the context of various other risks. This means that the tolerance for some specific risks may be much higher than outsiders would expect. How actors construct knowledge about risk prioritisation needs to be examined explicitly to understand why people react as they do (or do not). It also means that how varieties of knowledge are constructed and used in decision-making within local socio-political contexts needs to be understood. Thus, our third question deals with how these processes influence the outcomes produced, examining how disasters are socially constructed through risk tolerance and/or normalisation in decision-making and implementation.

We focus on different scale levels within and around metropolitan Lima, not only because cities are strategic locations for socio-economic development, where awareness and prevention need to be built up (IPCC, 2014a), but also because they illustrate the full complexity of vulnerability issues and governance processes in which construction of disaster processes are embedded (Miranda Sara et al., 2014). With this article, we set the basis for a future in-depth analysis of how risk perceptions and tolerance, spatial knowledge and iterative and interactive governance processes are linked to interventions, which can reduce or increase vulnerability and potential disasters at metropolitan, city and settlement scale levels.

7.2. Current debates on water-related risk perceptions and climate change

7.2.1 Risks, disasters and climate change

Three strands of current debates in the literature on water-related risks, disasters and climate change are relevant for this article: the social construction of disaster, disaster risk reduction and climate change governance.

The first strand is the social construction of disaster, a concept well-developed in Latin American literature (Aragón-Durand, 2009). Already in the 1980s, Peruvian and Colombian contributions from La Red, coordinating with international support, NGOs and academics (Blaikie et al., 1996; Fernández, 1996; Maskrey, 1989), focused attention on the concept of risk management and the realisation that disasters are not ‘natural’ - they are not part of the landscape, but rather a result of how humans construct physical infrastructure in the landscape. Current forms of urbanisation actually ignore natural processes; the blame for disasters is not to be placed on nature, but rather the way that cities are built. Going beyond the socio-ecological system approach to vulnerability, this political ecology perspective is firmly anchored in ideas on socio-natural relationships (Zwarteveen et al., 2014). The social construction of disaster in the Latin American context refers specifically to risks related to high levels of informality, ‘laissez-faire’ construction policies in parallel with a history of ‘self-help’ forms of urbanisation to combat housing deficits (Fernandez-Maldonado et al., 2010). High levels of migration and informal city expansion, having used those policies,

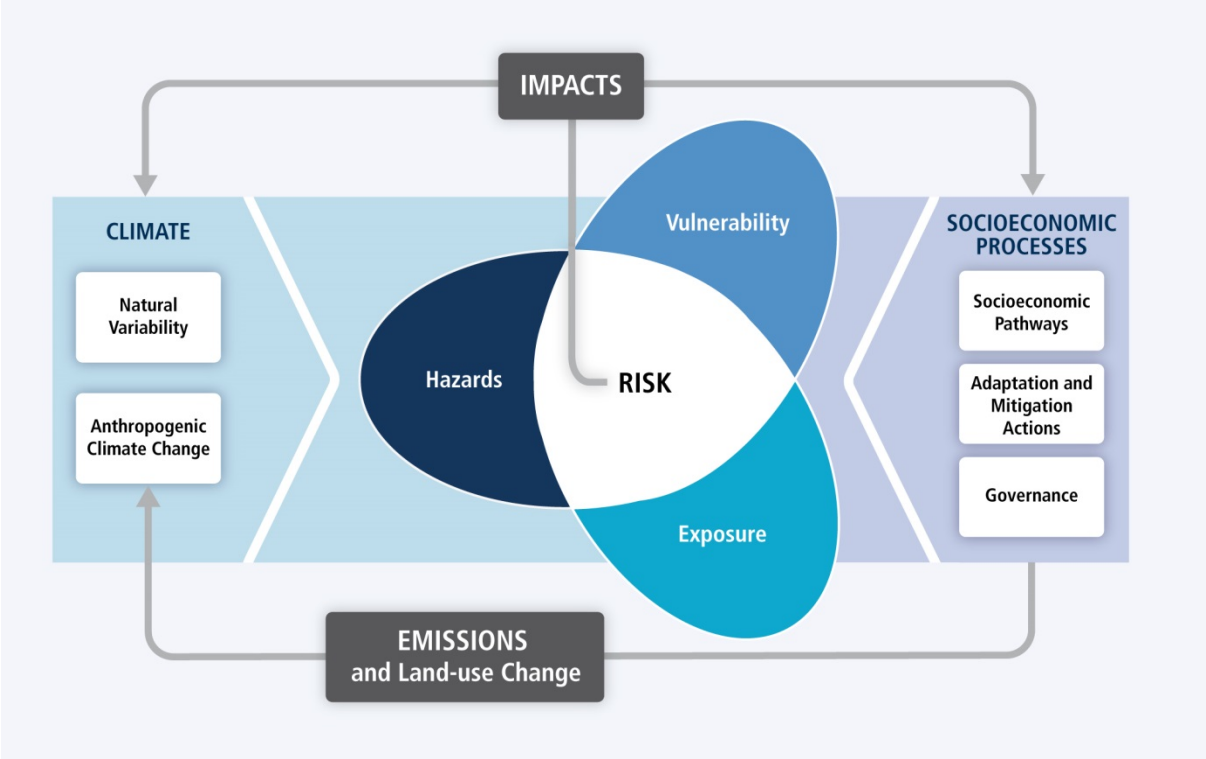
means that migrants are disconnected from the historical environmental context, and as a result, disasters occur when people are not [willing to be] aware of the dangers of particular locations[182].

Disaster risk reduction is the second strand of literature, based on these self-urbanisation processes and the development of proactive tools aimed at dealing with risks before disasters occur. This incorporates the necessity to prevent several risk phenomena simultaneously and to include the relationships and synergies between them in risk evaluations, as well as the decisive role of multiple government levels in prevention, response and reconstruction strategies. Nationally, disaster management is often the role of the civil defence ministries (Sperling et al., 2005), although in Peru such responsibility is in practice delegated to local authorities who have significantly less capacity and funding to deal with disasters (Allen et al., 2015; Cortez et al., 1998) [183]. Civil society organisations and communities are slowly being acknowledged and recognised as key actors in risk reduction strategies for successful implementation[184]. Globally, there is a more generalised and mainstreamed approach. For example, the UN Hyogo Framework (2005-2015), the SENDAI Framework (2015-20130) and the UNISDR drew on these central ideas (pro-active tools to deal with risk before disasters occur) to evolve the concepts of risk reduction and building resilience.

The third strand of literature is climate change governance, evolving since the 2000s, which emphasises national and global agreements. This approach is epitomised by the IPCC's (2014a), definition which presents a conceptual model of risk as the intersection between vulnerability, potential hazards and exposure to shocks and stresses, mediated by socioeconomic processes, climate and large scale biophysical changes, involving different scenario levels of greenhouse gas (GHG) emission and governance (see *Figure 7.1*). Importantly, this model highlights that it is the combined inter-linkages, which produce risks with the potential to become disasters (Romero-Lankao et al., 2014). This approach is an evolution from previous conceptions, which focused on hazard plus vulnerability divided by adaptive capacity (Adger et al., 2007; Engle, 2011). Though at the time the recognition of social dimensions of adaptive capacity was seminal, the earlier formula did not recognise dynamic interrelations. This important contribution brings together two bodies of thought - disaster risk reduction and climate change management - in relation to risk reduction and climate change impact management (Figure 7.1).

[182] Although we focus on Latin America, similar risk patterns are found in other regions as well (e.g. van Voorst, (2016); McFarlane and Desai (2015)).
[183] Cortez et al. (1998) Manual Nr. 04 Cities for Life Foro.
[184] As shown in www.climarecentre.org/minimumstandards and www.partnersforresilience.nl (visited 06.12.2015)

Figure 7.1: Core conceptualisation of vulnerability, risk and climate change.



Source: IPCC WGII AR5 (2014c)

The three strands of literature noted above conceptualising risk are complementary and overlapping. A key difference is that disaster risk reduction approaches include broader categories of events that climate change approaches, such as earthquakes, tsunamis or volcanic eruptions, which are not climate-related (Schipper et al., 2006). Though they differ in disciplinary backgrounds, timescales and top-down vs. bottom-up approaches to governance, at their core all the approaches are trying to reduce vulnerabilities (Thomalla et al., 2006). All highlight the relationship between socio-economic processes in constructing risk, and risk reduction, particularly through institutional capacity-building and collaboration (Begum et al., 2014). The IPCC framework more explicitly involves governance and the role of emissions and [de]growth scenarios, which may define the needed levels of adaptation. The Sendai Conference (2015), working from the disaster risk reduction perspective, explicitly draws connections between sustainable development, climate-related hazards and disaster risk reduction agendas, using interrelated intergovernmental processes to do so. Our article takes up the issue of these connections by unpacking the social construction of knowledge processes and risk perceptions embedded in them, and their relation to decision-making and the resulting adaptive and/or coping actions.

7.2.2 [Mis]Perceptions of risk and climate change

In much of the risk literature, the perception of risk is a secondary concept, and authors assume it to be articulated by actors. However, the concept of risk perceptions needs to be problematised. Psychology informs how we react to risks related to climate change, in terms of coping processes mediated by appraisals, emotional management and cognitive reframing both before and after an action (Reser et al., 2011; van Voorst, 2016). Importantly, social psychology recently understands these processes of adaptation and mitigation as both individual and communal, influenced by the social construction of risk discourses and collective sense-making (Bankoff, 2004).

There is a long history of the denial of vulnerability, evasion or high levels of risk tolerance, unrelated to real facts (Baird, 1986). Risk tolerance and perception shape people's attitudes, their risk reduction behaviour and their stance in discussions with other actors. Risk perception is directly mediated by personal experience, in either producing acceptance of flooding as a risky event, or normalising the risks associated with it (Bankoff, 2004; Lawrence et al., 2014; van Voorst, 2015). The intangibility of climate change as a concept means that flood and/or drought victims judge climate change as a risk mediated by their environmental values (Whitmarsh, 2008). Similarly, individuals' lack of engagement with climate change depends on their perception of particular barriers, including other priorities, lack of knowledge, and distrust or lack of action by politicians and the community at large (Lorenzoni et al., 2007).

At an individual level, Gifford (2009) created a typology of psychological mechanisms of the misperception of climate change. Three major categories of misperception are here: 'limited cognition', 'sunk costs' and 'discredence'. Limited cognition refers to either ignorance, by not knowing a problem exists or not knowing how to react or undervaluing distant risks. Sunk costs and discredence are when risks are undervalued because of alternative beliefs, either by selectively attending to risks of immediate concern or by discounting them. For instance, the vast majority of people internationally believe that environmental risks are worse in places other than their own (Gifford et al., 2009). Active denial of risks can result from cognitive dissonance, especially when there are 'sunk costs' from previous financial investments. Also, risks can be discredited if the information source is not trusted, ambiguous or thought to be dishonest (Terwel et al., 2009). Cognitive dissonance, or the discomfort arising from inconsistencies in thought, attitudes and actions (Festinger, 1957), is easier to reduce by changing one's mind than behaviour, and thus perceptions are malleable and behaviour more fixed.

Van Voorst (2015) identifies different individual 'risk styles' of inhabitants of informal settlements in Jakarta, Indonesia, which differ strongly from the categorisations made by disaster relief organisations. Residents do not perceive flood risks as their main risk and devise their own strategies to prevent or minimise the consequences of repeated flood risks (van Voorst, 2015). When people or societies are continuously exposed to hazards and risks, they normalise the risk, meaning that over time they become habituated, and cognitively and materially adapt, lowering the perceived risk over time (Bankoff, 2004; Lima et al., 2005). Risk normalisation at individual and societal levels is a key feature of risk tolerance.

Lehmann et al. (2012) argue that implementing urban adaptation plans depends on decision-makers' information about the problem, incentives to act and resources, combined with context, institutional characteristics and actor-specific characteristics, which include perceptions, preferences, experiences and mental models. In Lima (Lehmann et al., 2012) and

Durban (Mather et al., 2011) for instance, climate change is not perceived as an urgent problem and this lack of urgency results in inaction.

In the specific case of Lima, Bieliech and Alegre (2015) report on how different key actors' perceived risks in Lima are characterised in three key strands. In the 'closed' perspective, actors perceived risks as disasters or shocks, (such as earthquakes), for which the government should build infrastructure for the vulnerable and poor. In a second 'wider' perspective, actors acknowledge multi-dimensional and interrelated hazards, with the entire population at risk, although the connection to decision-making processes was lacking. Last, in the 'intermediate' perspective, actors also identified climate change as a priority, though this was a minority opinion. The report concludes that Lima is a city where key actors do not acknowledge its vulnerability, and a more integrated risk perspective is needed. Not surprisingly, the Lima Climate Change Strategy has not been implemented by the new municipal administration since the new mayor took the position in January 2015.

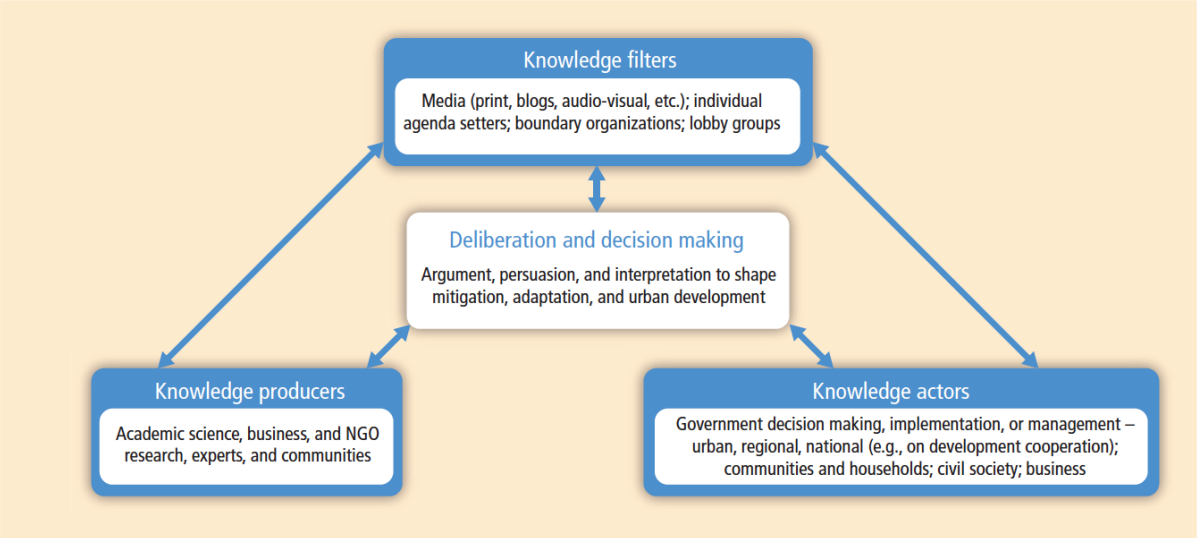
7.2.3 Risk governance and social construction of knowledge around climate change

We move now from the perception and framing of risks towards a social construction of risk perceptions, which investigates how actors interact together in risk governance. There is increasing recognition of the importance of multiple actors in risk reduction, evidenced by the move away from technocratic and managerial approaches towards risk governance, in particular, considering the embedding of multiple risks in a larger societal context (Renn et al., 2011). The political science literature on risk governance investigates these processes of deliberation in changing policy and decision-making. However, the assumption is that the perception, framing, calculation and estimation of risks as the starting point of risk reduction are straightforward and logical processes. The framing of risk is a depoliticised step in risk evaluation, with processes of deliberation taken for granted. Risk tolerance is inherent in this approach, in terms of calculating tradeoffs between financial and environmental systemic risks. This approach depoliticises framing risk by making it an exclusively technical domain (Li, 2007). The prioritisation of risk is linked to decisions about tradeoffs made in inter-relational governance processes.

Similarly, knowledge sharing is increasingly recognised as crucial to decision-making processes. For example, the Sendai Framework (UNISDR, 2015) has a whole section on understanding risk and building and sharing knowledge. However, there is an implicit assumption that merely making information and knowledge accessible is adequate for meaningful change. Knowledge is power and how knowledge is shaped by perception, interpretation and prioritisation is not addressed.

In the IPCC AR5 Urban chapter (2014b) as well as UCCRN (2015a), knowledge production is conceptualised as travelling through producers, filters, and users into deliberation and decision-making processes (see Figure 7.2). Here, only persuasion and interpretation are mentioned as parts of the deliberative processes directly connected to processes of urban development. However, if we recognise that knowledge construction may not immediately affect risk tolerance and (mis)-perceptions of various actors, we need to delve deeper into the question of how knowledge construction is linked to risk framing, risk tolerance and how these influence decision-making processes and actions taken to prevent disaster.

Figure 7.2: Conceptualisation of knowledge production



Source: IPCC WGII AR5 (2014c)

7.3. Methodology

This article analyses two case studies in which spatial knowledge was built around water-related climate change risk scenarios, which either already are or can become disasters (scenario-building). The first concerns the long-term possibility of water scarcity and droughts, while the second immediate extreme weather events that manifest as floods and El Niño. We investigate the first at the scale of metropolitan Lima and the second at the scale of a vulnerable community in eastern Lima. The cases illustrate iterative spatial knowledge construction, in which processes of risk prioritisation, normalisation and tolerance occur, and the resulting [in-]action by a variety of actors.

The methods of data collection are described for each case study below. The methods draw on the first author's twenty years of hands-on experience—action research—combined with fieldwork and interviews while working on climate change adaptation and water governance issues in Lima and Peru. The first case describes an interactive research project in Lima on long-term stresses related to plausible climate change scenarios, and the extent to which participatory knowledge-building processes led to changes in the mindsets and decision-making of the policymakers involved. In this case, the first author who was involved as the team leader of the Adaptation Strategy for Lima, which encompassed an iterative scenario-building process, analysed materials produced during the process and interviewed other metropolitan actors and researchers. The second case concerns a short-term heavy rain event scenario, where a poor and informal local community in Chosica, in the east of Metropolitan Lima, has suffered repeated flooding and disastrous mudslides in 1987, 2002, 2012 and 2014, culminating in the March 2015 disaster. The affected Chosica settlements are mainly the result of 20 years self-urbanised and self-constructed informal settlements in highly risky dry ravines. Despite government entities' warnings not to settle there, following a 'laissez-faire' urban policy, residents have received land titles, utilities and social services and are refusing to be relocated. In this second case, the first author collected and analysed expert/professional

and official maps over time on settlements in Chosica, outlining the urbanisation of risks, and how the informal settlements have been formalised. The first author also conducted short interviews with community members, functionaries and experts, and she reviewed TV and newspaper reports.

7.4. Empirical context

Peru is rapidly urbanising. Lima, the country's largest city and capital, has around 8.5 million inhabitants and is growing by over 90,000 people each year (INEI, 2013). As the city is located at the junction of three coastal valleys formed by the rivers descending from the Andean highlands, urbanisation is already growing through a double process of densification and over-crowding rather than expansion.

Peru is one of the ten countries most vulnerable to climate change in the world and one of the most affected by ENSO or El Niño (Adger et al., 2004). IPCC Fifth Assessment Report (IPCC, 2014a; Magrin et al., 2014) scenarios indicate that climate change along the South American Pacific coast includes the increase of droughts ('high confidence of glacier retreat in the Andes in South America'), combined with increases in frequency, intensity, and duration of extreme weather events like heavy rains, floods, landslides, and recurring events like ENSO ('high confidence of increase in heavy precipitation and risk of landslides and flooding in southeastern South America and northern South America'). Mudslides occur with flash floods down the dry river ravines (*quebradas)* during heavy rains. Economically, Peru's GDP might decrease by 6% by 2030 due to climate change stresses (Vargas, 2009). Yearly, 73 million dollars are lost because of disasters. Metropolitan Lima is also structurally vulnerable, with over 2 million residents occupying areas susceptible to floods, on hillsides with steep slopes, along with buildings and roads of insufficient quality (Rosenzweig et al., 2018). The city's exposure to rising sea levels and lower groundwater levels only compounds water-related vulnerabilities.

A climate change scenario-building process by the research project LiWA[185] as well as the development of the Adaptation Strategy of Lima with the Municipality set out three plausible climate change scenarios for Lima by 2040 or 2025. The process combined inputs from various experts and metropolitan actors. These plausible scenarios are frequent heavy rains events, permanent droughts, and a combination of both (Miranda Sara et al., 2014).

With only 9 mm of rain per year (SENAMHI, 2013) and located in a desert, Lima is already subject to water scarcity vulnerabilities. Its regional vulnerability is compounded by socio-economic inequalities in water distribution. Inhabitants of the richest areas consume around 460 litres per capita per day (lpcd), while residents in poor areas consume less than 50 lpcd (Miranda Sara et al., 2017). Those with no water connection pay ten times more than those with connections but consume on average less than 25 lpcd. (Miranda Sara et al., 2017). Water is also important to industry, as mining companies consume large quantities for which they pay almost forty-seven times less than citizens, and Peru itself is 60% dependent on hydropower for electricity.

Practices with respect to managing urban drinking water-related vulnerabilities in Lima are based on increasing supply rather than reducing demand. The water provision model of

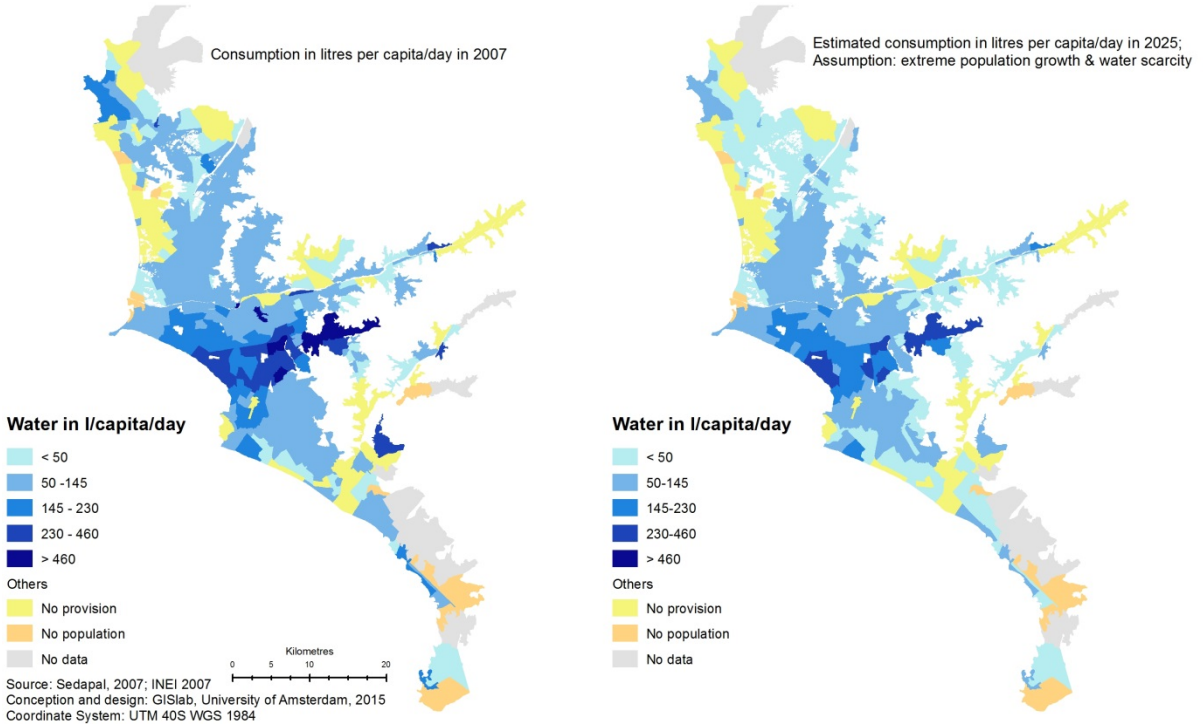
[185] http://www.lima-water.de/en/ visited 14.12.2015.

SEDAPAL, Lima's water company, is mainly based on piping in water from the other side of the Andes via large-scale infrastructural projects (Miranda Sara et al., 2015). Regarding broader risk management, the Peruvian risk reduction approach was implemented in 2011, when the national disaster prevention agency, CENEPRED, was separated from INDECI, the national agency responsible for emergency response. Local governments are encouraged to invest in prevention, though these actions do not always lead to adequate implementation.

7.5. Case 1: Is decision-making exacerbating extreme drought scenario-related risks?

The first case concerns a recent climate change scenario-building process carried out in the research project LiWA and the Climate Change Adaptation Strategy of Lima in 2012-2013. They set out three plausible climate change scenarios for Lima by 2040 or 2025; the process combined inputs from various experts and actors in Lima. These plausible scenarios explored the case of more frequent heavy rains, the case of more permanent droughts, and one scenario combining both (Miranda Sara et al., 2014). Here we analyse the potential consequences of the drought scenario identified. The scenario assumed an increasing population, rising demand for water and weak implementation of technology change and adaptation policies[186], where water provision would become critical, particularly for the most vulnerable socio-economic groups. Figure 7.3 shows that the differences in water consumption across water sectors (Miranda Sara, 2015a). The 2025 drought scenario on the right of Figure 7.3 shows that - if the unjust water consumption system continues - around 4 million people, or half of Lima's population, would be left with less than 50 lpcd 2050, excluding the tremendous decrease of water available for hydropower and industry.

Figure 7.3: Water consumption in lpcd in 2007 (left) and estimated 2025 scenario for extreme population growth and water scarcity (right)



[186] Pessimistic population growth rate of 2.3% and a decrease in available water flow of minus - 13.72%

Despite the iterative processes by which the knowledge on drought scenarios was constructed, tolerance of future risks remains high among key actors. Policymakers counter the conclusion that future droughts could reduce water availability with arguments that new grey infrastructure investments will keep future situations under control, using existing discourses about water as a commodity. SEDAPAL and most water users support such arguments[187]. That possible overexploitation of water might also generate different types of water injustice, particularly among the urban poor and those living in upper-river basins, is not given priority in assessing risks by these actors. Issues of protecting upstream water sources, reducing water losses, decreasing water consumption, and recycling are also notably absent from current discourses.

Tensions between actors also exist. The former MML administration (2011 to 2014) mapped urban poverty in Lima and prioritised risk reduction investments for the most vulnerable settlements as part of the MML climate change strategy developed in the same period[188]. In contrast with this approach, SEDAPAL still gives priority to large-scale (profitable) infrastructure projects, as does the dominant governance network of which it is part, consisting of ministries and large companies (Miranda Sara, 2004). The dominant perception of ignoring drought risks and focusing solely on extending infrastructure is based on mental models and ideas that 'nature can be controlled', and that there is enough knowledge, technology and management capacity to control any long-term stress situation (comments made during several short interviews, see also Miranda 2015). Other actors also prioritise immediate benefits; community groups in informal settlements prioritise water connections above other concerns.

The political decision of prioritising and solely expanding water connections or grey infrastructure rather than prioritising other options such as green infrastructure developed by the MML Climate Change Committee implies that longer-term drought risks are tolerated, or presumed manageable, with more large-scale (profitable) infrastructure projects. As a result, if the water distribution system, the technologies used and governance processes are not adapted, water scarcity will worsen for both urban and rural citizens, along with mines and industries. That scarcity of water will lead to depleted water ecosystems that would otherwise sustain the sourcing of water for the city and its territory.

However, a recent government initiative to protect water sources in the upper-river basin has created a fund with contributions for future water ecosystem services[189]. SUNASS, president of the green infrastructure group of the American Association of Water Rulers, gave approval for SEDAPAL to raise the water tariff by an extra 1% from (only) urban water users[190] and by 3.8% for adaptation to climate change since August 2015. This may create the basis for an important portfolio of future investments on green infrastructure protecting water sources, to be applied after 2016 in both upper-river basin and Lima, which will be managed by SEDAPAL. Another interesting initiative comes from the Housing Ministry, which recently

[187] There is no consideration of the possibility that water resources may no longer be available, such as in the current Californian experience (Mann et al., 2015).
[188] The risk reduction strategies consisted of prioritising the reduction of water demand in rich districts and reducing drinking water vulnerability in the poorest sectors of the hilly periphery.
[189] Law 302105, Government of Peru, which indicates that SUNASS can coordinate with the water companies to protect water sources, http://www.minam.gob.pe/wp-content/uploads/2014/06/ley_302105_MRSE.pdf and Ministerial resolution 398 – 2014- MINAM, http://www.minam.gob.pe/wp-content/uploads/2014/12/RM-N%C2%B0-398-2014-MINAM.pdf (visited 21.09.2015).
[190] 1,500,000 water connections, which may mean around 112,000,000.00 US $ investment portfolio since 2016.

approved a (voluntary) Sustainable Construction Code[191] which includes techniques for water-consumption reduction, energy efficiency and passive design. These are promising initiatives, which, if carried out effectively, may reduce current risks inherent in the unequal water provision and distribution systems. The perception of drought risks is slowly taking shape, but the prioritisation of such investments has yet to materialise.

7.6. Case 2: Social construction of the Chosica disaster

Chosica is a typically poor, informally settled area in the foothills on the banks of the Rimac River in the Lurigancho-Chosica municipal district of eastern Lima. The foothills are unsuitable for habitation due to their ravines (quebradas), which have flash floods and mudslides, combining exposure to local water vulnerabilities. These environmental risks are well-documented but were ignored during settling and regularisation of the areas, a process in which established settlers even received land titles and service connections ten years ago. A series of technical maps show how perceptions of risks in already settled areas decreased over time as part of local political processes, increasing risk tolerance and ultimately socially constructing the recurring Chosica disasters.

On 23 March 2015, after three hours of heavy rain, the Rimac River overflowed in the Chosica and Santa Eulalia areas, at the same time that nine mudslides, water and heavy rocks came down the mountains through the *quebradas* (see Figure 7.4). This was the worst disaster in recent years, in which nine people died, two disappeared, and 25 were injured. Over three hundred houses were damaged, with 108 destroyed and 45 declared inhabitable. The flooding blocked the eastern national highway, cutting off the city's food supplies completely for two days, and affecting water provision. An emergency was declared for 60 days in the District of Chosica[192], as well as in the Santa Eulalia sub-river basin. It was the culmination of a series of flooding and mudslides in Chosica. In recent years, the *quebradas* had had flash floods as a result of peak rains in the upper mountains with less drastic consequences. The Rimac River also flooded on 28 December 2012, 18 January 2014 and 10 February 2015 (Alliaga, 2015). These heavy rain events are recurring more frequently and are growing in size, in line with what the 'heavy rain climate change scenario' suggests. In 1987, several massive mudslides hit several settlements in the same ravines as the disaster in 2015, killing over 100 people, damaging 1,052 houses and affecting 3,000 people (Abad Pérez, 2009) (see Figure 7.6).

Although the facts of the disaster are indisputable, the disaster itself results from a process by which definitions of risk were tolerated and normalised through interactions between local politicians, government and households that settle informally. This process is traced here through a series of maps which show how risk levels were reduced and normalised.

The earliest map was produced in 1988, tracing the mudslide disaster that occurred in 1987 (Figure 7.5). Then, in 2005, the National Institute of Civil Defence (INDECI) made two hazard maps of the area (see Figure 7.7 and Figure 7.8). One, Figure 7.7, is the hazard map of multiple risks in the Chosica district. Figure 7.8 shows only hydrological hazards in the same area. The areas defined as high risk are different in the two maps. From the expert point of

[191] Supreme Decree 15-2015-Vivienda.

[192] Emergency Plan of Action (EPoA) (2015), Chosica, Lima Peru, Floods and landslides, Red Cross, http://reliefweb.int/report/peru/peru-floods-and-landslides-emergency-plan-action-epoa-dref-operation-n-mdrpe008 Visited 17.11 2015.

view, this is logical, as earthquakes, fires, and other hazards are not included in the second map; however, for non-experts, the perception is that risks are not clearly defined. This ambiguity not only generates confusion; the discrepancies are used to strategically deny risks depending on actors' interests by using one map and not the other, strengthening arguments to prioritise actions other than risk reduction in certain areas. Let it be noted that the hazard maps were not accessible to the community, so the extent of the risks was unknown to and ignored by inhabitants.

Building on these hazard maps, INDECI then made the first formal inventory of hazards for micro-zoning in the Lurigancho-Chosica district (Figure 7.9). The map showed areas needing protection from mudslides in the bed of the *quebradas* (visible as two isolated light green 'fingers'), as well as the hills surrounding established settlements. The settled areas became designated as 'Zones eligible for building with some restrictions' (orange). Uncontrolled informal construction meant these areas had been built up, beyond the designated zones extending up the hillsides.

INDECI's recommendation to the municipality and its accompanying hazard maps were neither legalised nor approved, and largely ignored in resulting municipal land use management plan, approved in ordinance 1099-2007[193] by Mayor Castañeda of the Metropolitan Municipality of Lima in 2007 (Figure 7.10). INDECI's 'zone of protection from mudslides', where construction was banned, was not clearly defined.

On top of this, the land use management plan demonstrates how the informal urban settlements were formalised; as the *quebradas* were already settled, riverbeds and surrounding areas were marked as 'medium-density residential use' (peach colour). Even the no-build zone (light green), in the foothills, was already settled. Drawing parallels with Roy's (2009) understanding of the informal urban become formal, formalising informal settlements is part of normal urban housing policy in Lima, with politicians acknowledging realities in the field as opposed to future risks and vulnerabilities. On the first day after the Chosica disaster, Mayor Castañeda commented, saying 'I hope people have learnt their lesson'. According to O'Connor Salmon (2015), the Mayor himself does not seem aware that guiding urban development is his responsibility; 'corruption also means more and more *quebradas* with high-risk levels are being inhabited in the California area, where the company "Sol de California"[194] is selling plots right in the ravines' (See footnote 193).

In 2010, a hazard map was produced for the central government--that is, for the National Institute of Development (INADE), as part of a study to develop an environmental programme to recover the Rimac River basin - clearly showing Chosica as a high-risk area within a broader risky region (Figure 7.11). The implications of this were never taken forward, resulting in the disaster of 2015.

[193] Ordinance approving Land use zoning of Lurigancho Chosica beside others by Metropolitan Municipality of Lima, duly signed by Mayor Castañeda http://www.muniate.gob.pe/ate/files/documentosZonificacion/normas/ORD_1099_2007_MML_APROBACION_DEL_PLANO_DE_ZONIFICACION.pdf visited 14.10.2014

[194] http://gamasol.es.tl/

Figure 7.4: The mudslides in Chosica, showing several meters of deadly rock debris.

Source:
https://www.youtube.co m/watch?v=9EfewY3E94M (visited 15 April 2015). Screenshot by DineroVs.

Figure 7.5: Map showing the damage of the mudslides 1987 in Lurigancho – Chosica, Source: O'Connor 1988, INEI, PETT.

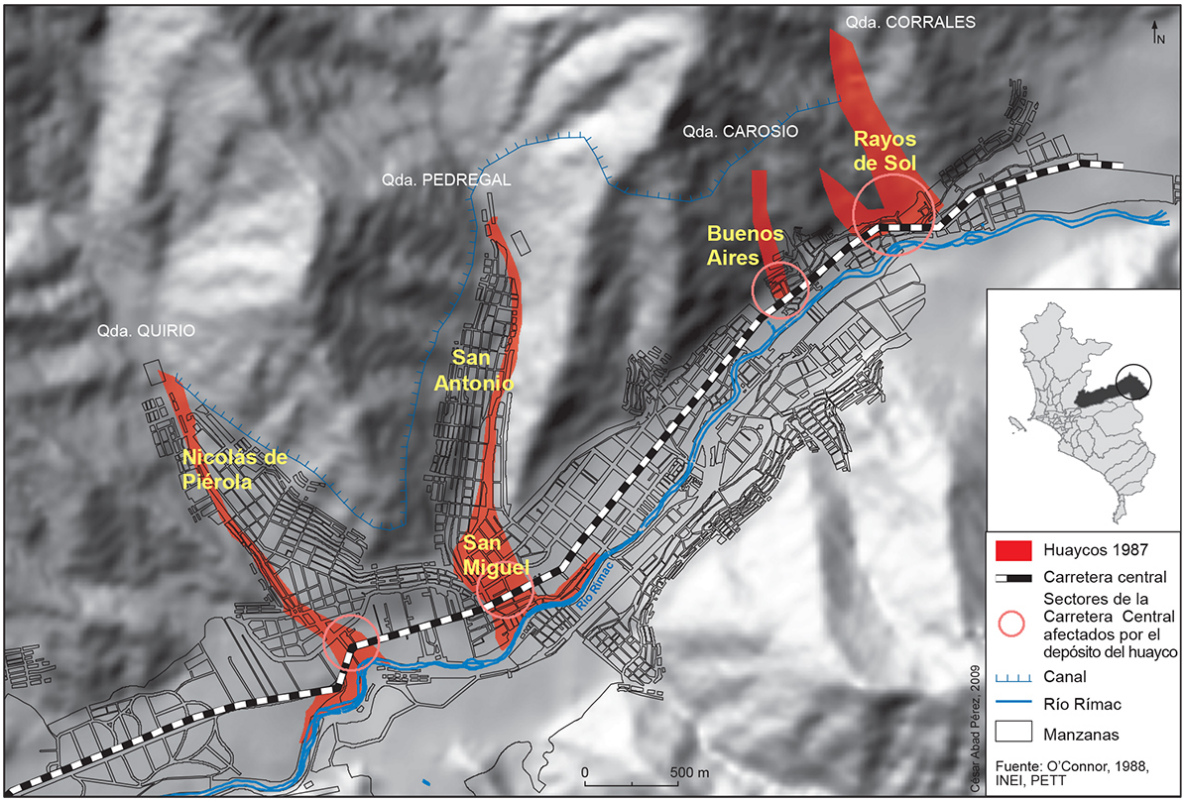


Figure 7.6: The disaster in 1987 showing the path of the mudslides in red and the damaged outlined in yellow.

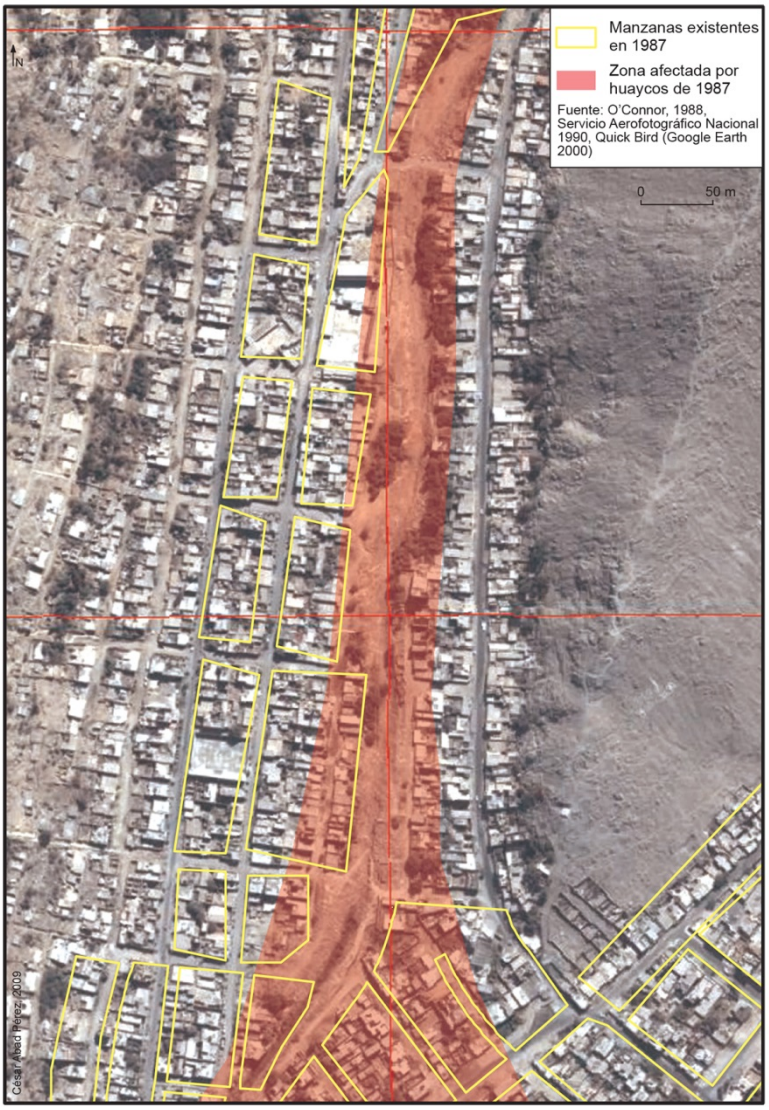


Figure 7.7: Map of multiple hazards of Chosica (INDECI, 2005).

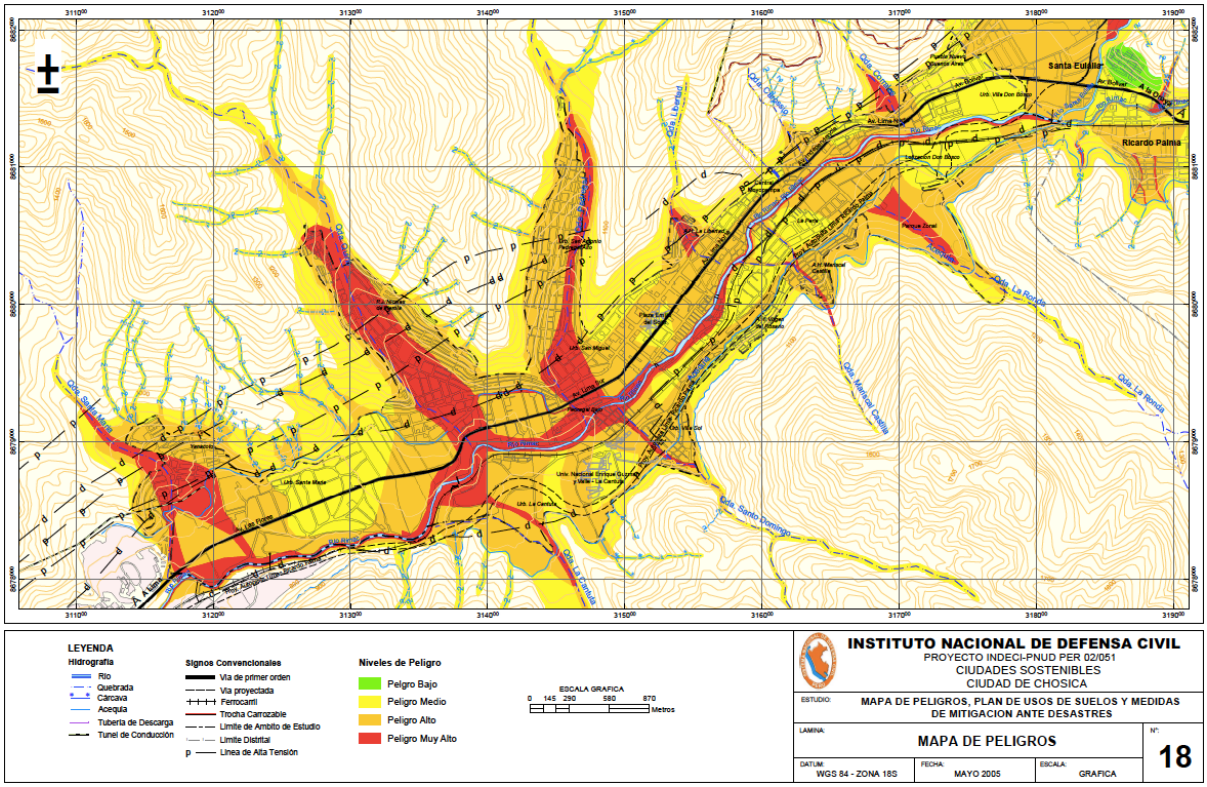


Figure 7.8: Map of hydrological hazards in district of Lurigancho Chosica (INDECI, 2005).

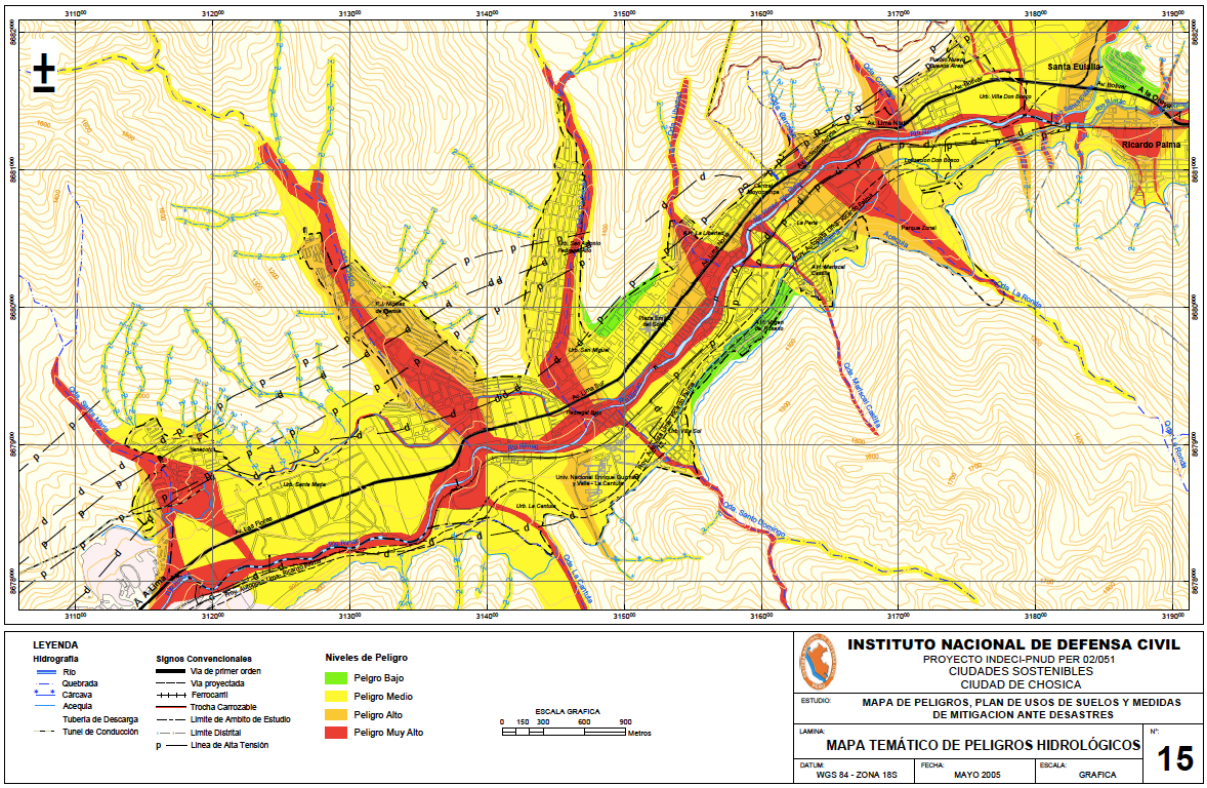


Figure 7.9: Recommendation for the land use plan of the area made by INDECI (2005) for the MML.

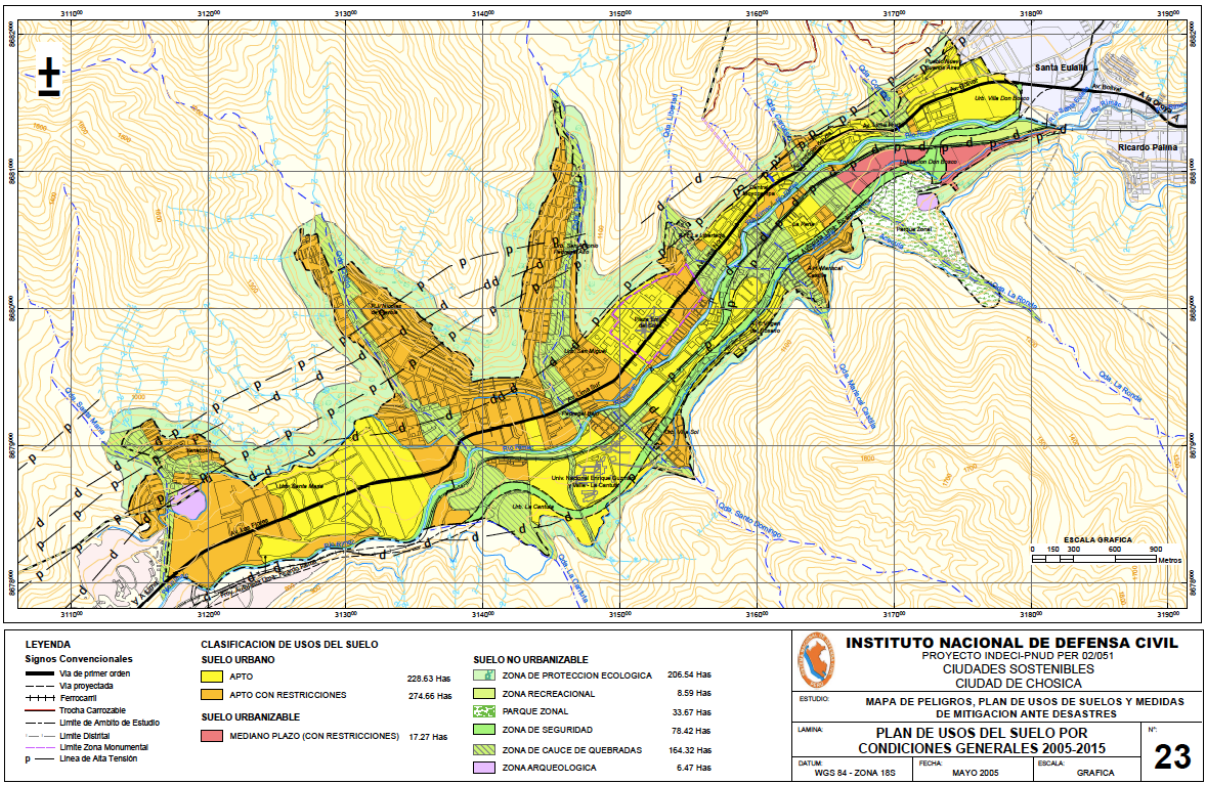


Figure 7.10: Municipally-approved land use map for Chosica (2007), which downgraded the risk as suggested by INDECI. Source: Ordinance 1099-2007.

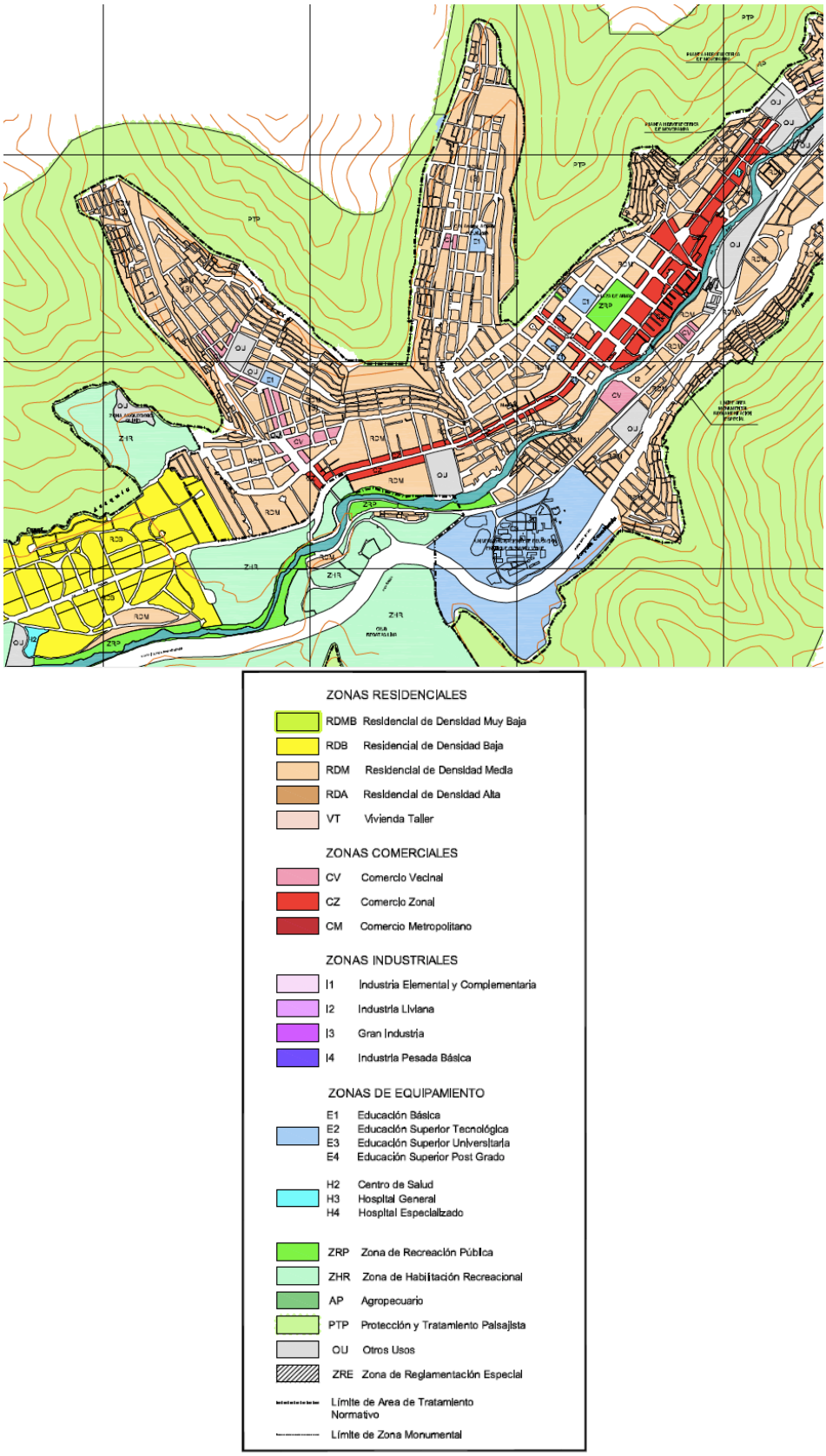
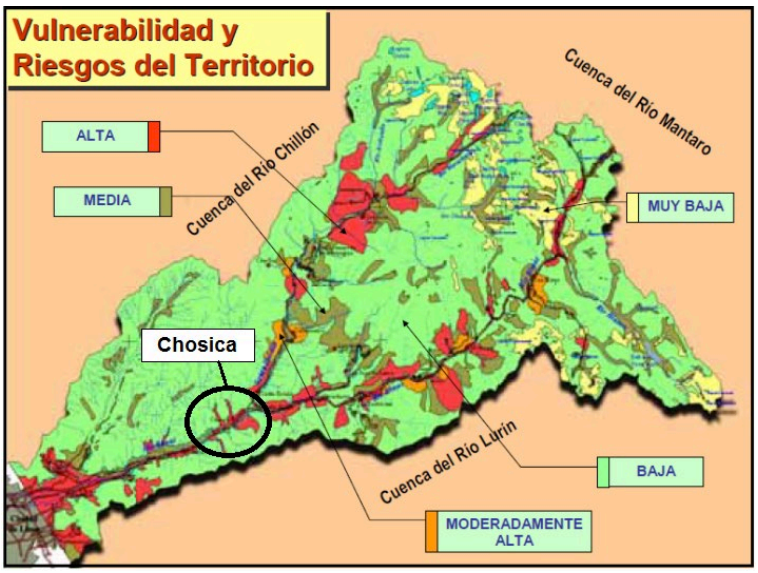


Figure 7.11: Hazard map produced for the central government INADE, showing the location of Chosica as only part of the broader risk landscape of the Rimac River and Santa Eulalia sub-basin.



Source: Llerena Pinto (2010) Alta, High; Media, Medium; Moderadamente Alta, Moderately high. Baja, Low; Muy Baja, Very low.

Knowledge about hazards and potential actions for risk reductions are not travelling between institutions and actors. The institutional mandates for risk assessment and management are fragmented. Because INDECI has split with CENEPRED, response, reconstruction and prevention are not tied together to provide adaptive responses. Responsibility for risk reduction in practice is relegated to local government and civil defence committees, which lack the capacity or political will to contravene residents' preferences, which remain adamantly against relocation. The laissez-faire approach towards informal settlements and policies slowly responding to their demands for basic services and collective infrastructure exempts the government from its responsibility to adapt. This means, that despite the disaster, demolition and relocation of the existing settlements are not considered options. Even now, houses buried under three meters of mud and debris are being cleaned out by their owners, who refuse to move. Their prioritisation of risks is focused on more immediate socio-economic concerns of housing, schooling for their children and community cohesion. Because they have put their life savings into their housing, they would lose their main asset when relocating elsewhere (even if land is provided).

The national government's ad-hoc approach is to train communities to handle disaster and mudslides through simulations. President Humala offered subsidies and financial support to relocate families.[195] The Housing Ministry offered free new land for relocation (meant to be ready mid-2016) and has approved the Legislative Decree 1226 in September 2015[196] to fund basic houses to most vulnerable families (from Chosica and beyond) for their relocation. The regulation for its proper implementation is still pending. Lurigancho-Chosica District Municipality is building dikes, embankments, reinforcing foundations and is cleaning the

[195] http://www.andina.com.pe/Ingles/noticia-peru-president-govt-to-support-relocation-of-families-affected-by-landslides-549213.aspx visited 14.10.205

[196] Bono Familiar habitacional para familias vulnerables http://www.elpino.com.pe/en/tag/fondo-mivivienda/ visited 14.10.2015

stream of rivers and ravines. Meanwhile, El Niño 2015-2016, considered a strong to very strong repetitive phenomenon, is expected to bring the extreme weather of the 2016 Peruvian summer again.

7.7. Discussion and conclusions

In this section, we come back to the questions posed earlier, analyzing the linkages between knowledge management and governance processes in influencing risk perceptions, through risk normalisation and prioritisation among government and community actors, and their subsequent outcomes. The first question concerns the perceptions of actors on vulnerabilities and risks. The cases show that clear differences exist in the extent to which plausible water-related climate change scenarios as short-term stress (flooding, extreme weather events, current water inequalities) are recognised versus long-term stress (droughts, water availability, injustices). Generally, communities do not prioritise long-term stress due to their preoccupation with immediate risks and socio-economic concerns. This suggests that they normalise the existing risk context. Local governments and real estate companies selling plots in the ravines go along with these community concerns, both because of laissez-faire attitudes and political and economic concerns.

The second question concerns how specific risks are tolerated or prioritised, and how are they linked to decision-making processes. Our cases show that the social construction of knowledge on vulnerabilities themselves is important, but not enough to understand how such knowledge is incorporated into decision-making. Knowing about risks and vulnerabilities is not enough, as risks can be normalised or prioritised in different ways to deal with political, cognitive and emotional dissonance that occurs when other, socio-economic, interests come into play. In the IPCC model (Figure 7.1) risks are linked to knowledge and deliberations (in governance networks) as if these processes are very smooth. Although the cases show that knowledge construction does need to be linked to deliberation and decision-making, unless the politics of decision-making are considered it cannot be understood why some information is inaccessible or taken as ambiguous, or striking knowledge is ignored, denied or forgotten. Decision-making at the individual or small group level also needs to be recognised as the result of cognitive dissonance (sunk costs, or different risk prioritisation) at the individual and network level. Processes of risk normalisation and prioritisation at both levels need to be included in analytical models.

The third question concerns the outcomes found in terms of (spatial) knowledge produced, changes in decision-making, and exacerbation of vulnerability and risks. Both case studies show that ignoring existing knowledge towards plausible future risks contributes to the ‘socio-natural construction of disasters’. With the long-term stress of drought scenario which would reduce water availability, and if water distribution does not change, it will create hardships and conflicts for increasing numbers of people, both in Lima city and among upstream peasant communities, as well as with large influential water consumers and companies. Disasters occur when several things go wrong simultaneously - building on risky slopes, lack of preventive measures, recurrence of stronger short-term shocks, extreme weather events and the reluctance of people to relocate without acceptable compensation, preferring to stay together as communities came together in Chosica. Overall, that the IPCC model links knowledge management, decision-making and the plausible GHG scenarios is a great improvement. However, this article illustrates that spatial planning is a political process (Flyvbjerg, 1998), in which knowledge is contested, or even when knowledge is taken into

account, does not necessarily steer decision-making processes, either by local communities, authorities or private interests.

The conclusion is that existing models linking knowledge construction to risk framing, risk tolerance and how these influence decision-making processes and actions to prevent disaster, ignore the issues of risk tolerance, through normalisation and prioritisation, at their peril. By including these issues in our analysis, we can build a better understanding of what is required in order to build effective adaptation and response processes. These forms of risk tolerance feed into all aspects of adaptation processes and thus must be considered if meaningful change is to be generated.

Chapter 8. Conclusions

In this last chapter, I come back to the main issues raised in the thesis and address the answers that research has provided in order to draw out the main conclusions and reflections concerning the analytical framework and contributions to the debates. The main research question was how (metropolitan) water governance is (re)configured in the context of current weather trends and future risks attributed to climate change scenarios, and how it is linked to knowledge-building processes.

This analysis draws on three debates. First, it utilises the new concept of sustainability as the basis for a meta-analysis approaching developmental processes with a holistic vision where nature (particularly the water system) is recognised as an actor exercising its own power (how water flows follow the hydrological cycle). Incorporating nature, particularly water, as an actor having both agency and power, changes the approaches to exercising governance and water management and fosters a new perspective on sustainability. Considering nature in the analysis may lead to a more complete understanding of the extent that risk and vulnerability, with recurring shocks and long-term stresses, produce conflicts, sickness and loss of lives and infrastructure.

The second debate concerns the understanding of governance networks as configurations, consisting of the discourses used, actor coalitions and networks, the iterative and (inclusionary) constructions of knowledge building (including spatial knowledge) within *concertacion* processes. It also includes the power struggles of actors around decision-making processes and the dynamics of the territorialities in practice which lead to specific outcomes (Baud et al., 2014; Pfeffer et al., 2013; Sutherland et al., 2015). This debate concerns how neither the state internally nor water governance configurations are homogeneous structures but are built up of actor networks working within institutions, and in the process changing continuously.

The third debate focuses on risks, particularly those related to water, and attributed to climate change. There are three strands in the literature on water-related risks and climate-related disasters: the social construction of disaster, disaster risk reduction and climate change adaptation. Although each strand takes up essential issues, they still do not speak to each other and miss out important issues. The social construction of disaster helps to understand how mainly local societies build and reproduce their own risk. This approach contributes to the disaster risk reduction by mobilising participation to prevent and mitigate them. Disaster risk reduction is mainly concerned with central government responses and reconstruction. It both observes the past tendencies and makes projections for the future. Climate change adaptation instead observes global temperature tendencies and projects them towards the future, indicating the new climate risks that societies will face, which are not found in past events, but without making in-depth analysis of the local impacts.

This thesis contributes to these debates, as it has developed an analytical framework which identifies and analyses the interconnections between the hydrological cycle in the territory, the configuration of water governance networks in a metropolitan context, and how knowledge and spatial knowledge in particular are socially constructed within different actor networks through a variety of inclusive and interactive processes. Moreover, this thesis contributes to the understanding of the extent to which climate change and its related risk discourses are recognised and connected to interactive governing processes for making cities

more sustainable. This is done by using scenario building as inclusionary policy knowledge-building processes.

The main research question is the following: How are Lima´s water governance networks being (re)configured in terms of discourses, actor network coalitions, territorialities of practice and inclusionary knowledge-building processes in order to face water-related risks, vulnerabilities and inequalities associated with climate change?

The four specific research questions discussed in the following sections were:

1. How are Lima's water governance networks (re)configured, in terms of its main actors, discourses and practices, power relations, policy knowledge flows, territorialities and outcomes?
2. How do mapping processes construct new knowledge through iterative knowledge construction in *concertación* processes in Lima and reveal the uneven geographies of water-related (climate change) risks, vulnerabilities and inequalities in cities (and territories)?
3. To what extent do *concertación* processes exchange knowledge, build trust and enable joint planning, and how does the (ex)inclusion of different types of knowledge contribute to them?
4. How do knowledge construction and risk perceptions of water-related disaster risks and vulnerabilities affect the decision-making and implementation in metropolitan governance networks?

Metropolitan Lima, the capital city of Peru, is a relevant case study to examine how water governance is configured and how it deals with volatile climate trends and subsequent risks analysed in future climate change scenarios. Peru is one of the world's ten most vulnerable countries to climate change, with the recurrent effects of El Niño (ENSO) exacerbating its vulnerability and producing new risks. Lima city, with almost ten million inhabitants, suffers from both water stress and flooding disasters, altogether with unequal distribution of water, variable pricing and lack of access to water. In addition, Lima is the second driest city in the world and is highly vulnerable to drought.

This research started with the premise that the relevant actors (public, private, politicians, community, academic and others) or actor networks can and do use their discourses, knowledge and power relations to influence water governance structures/institutions, decision-making processes (participatory or not) and outcomes in their cities and territorialities (Pahl-Wostl, 2015; Torfing et al., 2012). The extent to which democratic governance processes and participatory interactive management processes are linked depends on the degree of inclusion (*concertación)* and transparency in the processes concerned. *Concertación* as a learning-by-doing process allows actors to contest and confront each other in being heard. Such processes are dynamic, depending on the types and the extent of knowledge produced, utilised, shared or hidden and the power imbalances, with transparency being a key factor. For instance, the Lava Jato corruption scandals raised to 79% the distrust of citizens towards government institutions and the perception of corruption in 2017 (being 65% in 2019); at the same time, 79% believe they can make a difference, that common citizens can help stop corruption, an increase of 17% in relation to the 2018 report (Transparency International, 2019).

Before going into the conclusions, I want to again clarify where I stand as a researcher in terms of discourses on water, cities and sustainability, as well as my main approach to governance processes. In terms of discourses, I see water as a socio-ecological good (Miranda Sara et al., 2014b); I see cities as a node of crucial territorial practices, I utilise the concept of new sustainability (cf. chapter 2), and I study *concertación* processes as a Peruvian form of democratic processes, participation, social learning and knowledge building. The analytical framework centred on 1) water governance actor network configurations, 2) policy knowledge construction through scenario-building and sharing within *concertacion* processes, and 3) territorialities in practices.

The research focused on problem-solving and process-oriented action-research character. It has generated academic products and contributed to policy processes, involving a 'social learning by doing' process. It started in 2010 and for this dissertation, ended in 2018 (with a break between 2016/2017). During that period, multiple real actors from diverse institutional levels, sectors and disciplines at different geographical scales were invited to participate in knowledge-building processes in different ways, developing the ability to anticipate long-term scenarios (and visions). Dialogues and debates with the public on social media such as Facebook and Twitter were also used, as part of a wider process of the social construction of knowledge. This indicates that a wide spectrum of actors has been involved in the research process. Nevertheless, while I am responsible for the results, it is necessary to acknowledge the many and varied contributions of the FORO in the research, with the contributions of many other actors.

Within the context of participatory and action-oriented research, several methods of collecting and analyzing data were used. These included interviews with strategic actors and community members in advocacy processes. In the latter, I discussed how their discourses influence and interconnect within an actor network governance configuration and how important a spatial analysis is, following the flows of water within a hydrological cycle and territorialities of practice. This approach has helped to understand the level of inequalities and vulnerabilities with metropolitan cities, such as Lima. This analysis needed a multi-institutional level, multi-scalar geographical perspective (Pahl-Wostl, 2015) as well as the temporal analytical framework with multi-actor involvement, utilising focus groups and secondary data analysis transformed into spatial scenario visualisations.
The following sections answer the specific research questions posed, which together provide the building blocks for answering the main research question.

8.1. (Re)configuring water governance networks

The first specific research question is about how metropolitan governance networks work. One important debate around metropolitan governance networks is how government works with different actors (private sector, civil society, academia and others), and the extent to which the discourses and knowledge from different actors produced, utilised and shared/hid, is actually included in decision-making processes, and how this influences various outcomes. The literature has suggested there has been a shift from directive government policy and practice for public provision to a situation in which government is a primary actor in a network of different actors who altogether decide (Pierre et al., 2000). Public-private partnerships can have exclusionary effects through pricing and allocation processes, particularly for poor households (Batley et al., 2001). The processes of governance including civic organisations are said to be more interactive, drawing in a variety of actors, through multi-scalar relations and iterative consultative processes, although unequal power relations

often prevent vulnerable societal groups from having a voice (Healey, 2007; Torfing et al., 2012).

In this context, metropolitan water governance networks in Lima are analysed, drawing on the concept of governance configurations developed from the discussions in the context of the Chance2Sustain programme in which I co-chaired the water governance Working Group activities (Baud, 2015; Miranda Sara, et al., 2014b; Miranda Sara et al., 2011; Sutherland et al., 2015). These dimensions include a) the actors and networks involved, b) their mandates and discourses, c) power struggles around decision-making processes, d) knowledge building and e) goals and outcomes. In this research, the focus was more explicitly on water governance networks, and the dimensions of f) policy knowledge flows as a source of power and g) territorialities of practices (spatial perspective), adding to the strength of the configuration concept.

Specifically, the study traced how discourses, policy knowledge flows, power relations and mandates across territorialities (re)configured water governance networks in metropolitan Lima and surrounding river basins. Specifically, four discourses, four actor networks (see Figures 8.1 to 8.4 below) with different levels and types of power to influence policy development (conflict, negotiation and *concertación*) were identified, analysed and validated. These actors include the main legislative and regulatory institutions, institutions dealing with water sourcing, provision and allocation to industry, mines, energy, agriculture, drinking water and wastewater, as well as organisations involved in discussions on redesigning the water governance (non-governmental organisations (NGOs), civic organisations (CSOs) and international agencies).

Figure 8.1 Network A Investors (dominant)

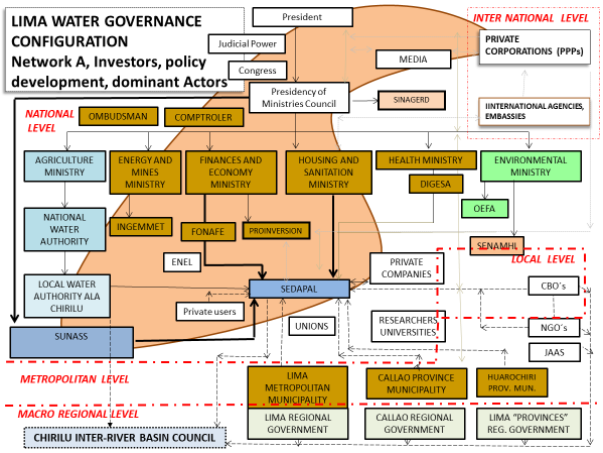


Figure 8.2 Network B Regulators

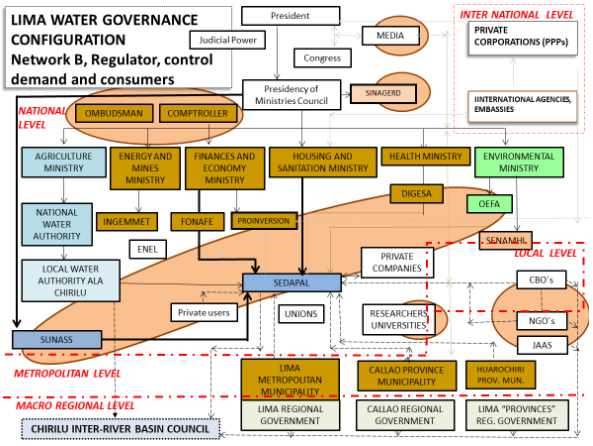


Figure 8.3 Network C Inter river basin

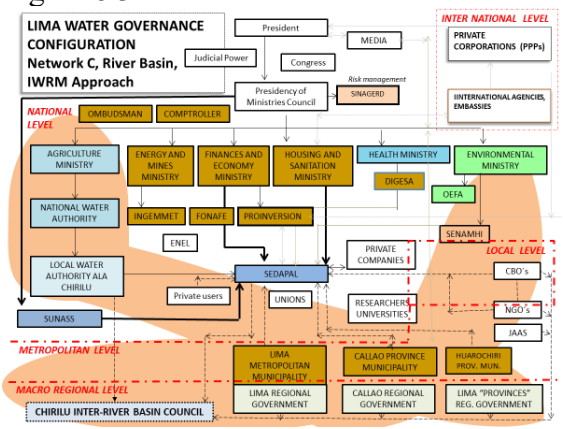
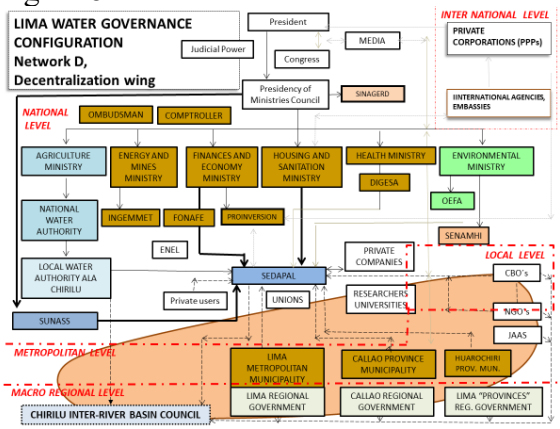


Figure 8.4 Network D Decentralisation



Note: the coloured area reflects that each network of the boxes is sectoral: urban (brown), water (blue), risk (pink) and environment (green).
Source: Author 1, November 2017 updated version based on Miranda, Baud and Pfeffer (2016)

The results showed that dominant discourses on water governance do not recognise the existing interactive water governance processes, which included more dynamic interactions of multiple actors. Existing power relations led to the dominant Investor Network A, where the territorialities and (parts of the) hydrological (ecological) system were recognised and/or ignored in practices, and their resulting outcomes were very uneven in terms of universal equal water provision and sustainability of the hydrological cycle. The interactions between them shaped the territories of practices concerning water flows and the hydrological cycle. The dynamics of these networks also reconfigured power relations.

Opportunities for a different socio-political and technological water governance configuration may emerge as based on socially-supported agreements (Miranda Sara et al., 2014). The main conclusion is that the dominant network A sets discourses, rules and implementations, while power relations are being renegotiated. New emerging networks included wider communities, but their power remains limited. The water governance configuration also faces the paradox that current water demands of all the users combined may no longer be feasible within ecological limits and future climate change consequences (Miranda Sara et al., 2016).

8.2. Iterative knowledge construction in *concertación* processes

The second specific research question dealt with how various discourses influence the knowledge-building processes in terms of their main concerns, water sector boundaries and the types of knowledge/information that are considered legitimate. The processes were assumed to be embedded in the urban configurations, and the legitimacy of mapping processes would need to be negotiated across social and sectoral boundaries. One of the main assumptions in the literature is that the participation of multiple actors in iterative and interactive processes reduces conflicts and opens spaces to include new sources of knowledge. The negotiation processes permit (or negate, refute and exclude) the validation of the variety of participating actors' knowledge, establishing very delicate and complex processes of dialogue-negotiation-agreement-conflict management to achieve viable pacts, contributing to create consensuses (or not).
In other words, the processes involve different kinds of knowledge from multiple actors, such as i) tacit, ii) context-embedded community knowledge, iii) context-embedded professional knowledge and iv) expert/scientific knowledge[197] (Pfeffer, 2018; Pfeffer et al., 2013) without excluding or making invisible, negating or refuting any form of knowledge. Given that knowledge stays where it was generated, searching for fluid forms of mobilising it and sharing it for a collective co-generation of knowledge (particularly regarding risk in Metropolitan Lima) was an important challenge.

Iterative mapping processes within three *concertación* processes in Lima were analysed, revealing the uneven geographies of water-related vulnerabilities and inequalities, and the outcomes were presented in the cross-boundary processes of social construction for generating, analyzing, and exchanging knowledge on water vulnerabilities.

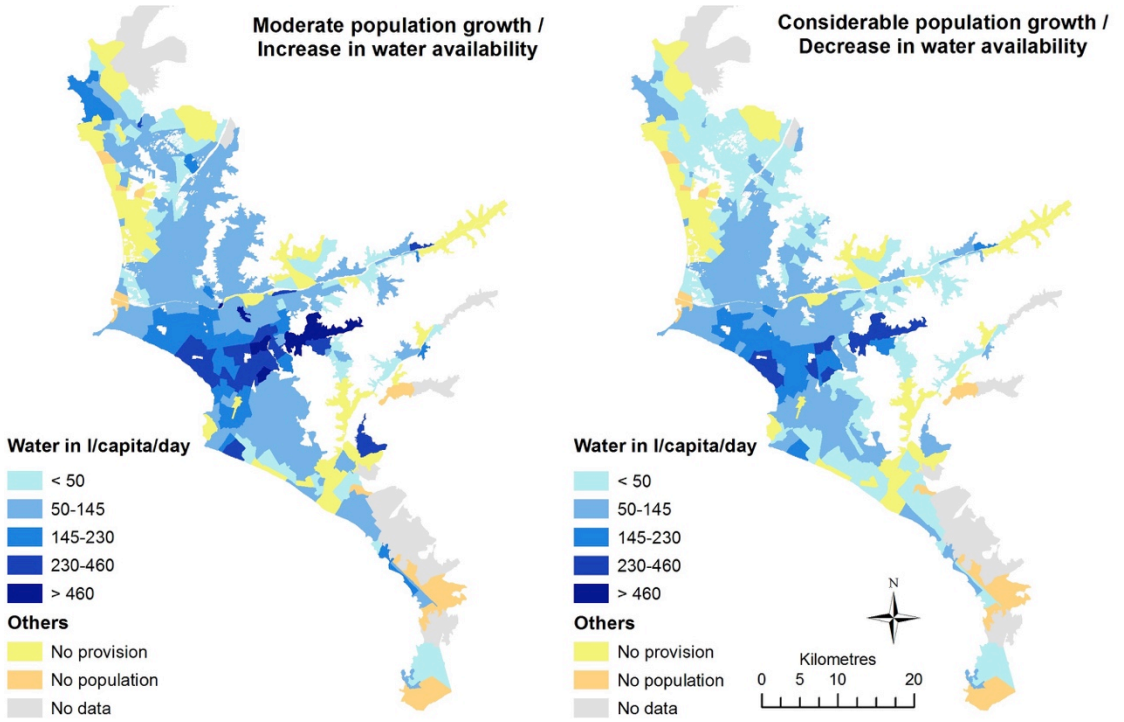
[197] Knowledge published in refereed publications, according to scientific methods

The three research and policy-building projects in Lima reflected how mappings of unequal water distribution and 'water-related vulnerabilities and risks' are socially constructed. First, maps drew on different discourses and framings, data inputs and classifications at multiple territorial scales. Second, they visualised spatial water inequalities and linked multiple dimensions to one geographic locality, building a more integrated understanding of the dynamics and spatial differentiation of Lima's 'waterscape', which combined both human and natural processes. As a result, it became easier to discuss the legitimacy of different types of knowledge with various actors. Third, the maps facilitated 'exchange on priorities, conflicts and synergies', providing inputs into the negotiation processes between the different actors in water governance configurations. Although mapping has produced new kinds of knowledge, results still need to be incorporated into policymaking and implemented for broader acceptance.

One mapping exercise was done to calculate the future water consumption based on the estimates of future water resources (no change, an increase of 6.28%, a decrease of 13.72%, determined in the scenario-building processes within the LiWA project) combined with different population projections – (realistic growth[198] (1.3%); pessimistic growth (2.3%); optimistic growth (0.3%) which vary by district). Maps were produced by integrating water consumption data from November 2007 collected from the SEDAPAL, population data from the population Census (taken in November 2007 by INEI), official population projection rates by districts (INEI, Census data) and official categories of minimum water demand of 80 litres/person/day (WHO). The mapping was done at water-sector level, at which level population (projection) data were also aggregated. The maps produced displayed two contrasting scenarios – moderate population increase and resulting in more water, and a considerable population increase and resulting in less water (Figure 8.5.). The maps were discussed in five workshops and various seminars with various key actors and experts, and the maps continue to be used.

The maps showed how uneven the distribution of water is. This inequality is also shown in the pricing system, where households in central residential areas receive over 460 litres/person/day with no subsidies; while the greater part of the population which lives in steep areas in poor households (where pumping water would increase costs to SEDAPAL) have social tariffs or subsidies. However, they receive less than 50 litres/person/day; those unconnected to the system were estimated to receive less than 30 litres/person/day. Levels of payment were also very unequal across the different social groups where actors from the private sector were involved. Economic efficiency and short-term profits take precedence in these decisions rather than long-term hydrological sustainability for SEDAPAL. The current drinking scenario of water production would not be enough to provide everyone in Lima with the WHO's minimum norm of drinking water, even if it were equally distributed (Miranda Sara et al., 2016).

Figure 8.5 Increase in water availability, combining population growth and future water consumption estimates, without changing existing unequal distributions



Source: SEDAPAL consumption data 2007, INEI (2007); Chance2Sustain project, produced by Pfeffer, Miranda Sara and Kesarovski in 2013

A main conclusion about the second specific research question is that action-research and policy-building processes can reflect how the mapping of 'water-related risks and vulnerabilities' are socially constructed. First, maps draw on different discourses and framings, data inputs and classifications at multiple territorial scales (Martínez et al., 2016). Second, they visualise the inequalities linking the multiple dimensions, building a more integrated understanding of the dynamics and territorial differentiation of Lima's 'waterscape', combining human and natural processes (Sutherland et al., 2015), legitimising the discussion of different types of knowledge among actors. Third, maps facilitate 'exchange on priorities, conflicts and synergies', providing inputs into negotiation processes between actors in water governance configurations. But inclusive and participatory processes are still needed to ensure that they are incorporated into policymaking and implemented for broader acceptance.

8.3. *Concertación* processes, knowledge exchange, trust and inclusion

The third specific research question pertained to what extent *concertación* processes exchange knowledge, build trust and enable joint planning (and how the exclusion or inclusion of different types of knowledge affects them).

The concept of adaptive management is increasingly being used in the debate on adaptation to urban climate change where social and organisational learning is essential, and both planned actions and responses to unexpected shocks are necessary. Building up the knowledge

involves learning from experience, adding to codified knowledge and proposing future actions. A major assumption is that participation by the key actors is crucial in building consensual agreements, reducing conflicts and opening up new sources of knowledge. The main concerns remain regarding what types of knowledge are included (context-embedded community knowledge) and how the variety of actors are included in more hybrid networks (Scott et al., 2009).

In Peru, *concertación* processes involving a variety of key actors have become mandatory in various contexts. The key characteristics are learning-by-doing, combined with constructing knowledge through various social networks. The latter implies the validation (or contestation) of the knowledge of a variety of participating actors, and a highly sensitive and complex process of dialogue-negotiation-*concertación*-conflict management and consensus-building (or not). Such processes can be seen as cycles which constantly evolve.

The research, which focused on water-related risks and inequalities in Lima, examines different contribution processes from socially constructing knowledge to transitions in metropolitan water governance and climate change adaptation strategies. The research also focuses on the extent to which *concertación* processes include a wider range of actors, discourses and knowledge in metropolitan governance and adaptation strategies, and how these processes influence shifts in setting priorities in policy decision-making, which such processes are supposed to incorporate.

Specifically, the study focused on and analysed three processes, which were carried out in the same period, and concerned discussions on the consequences of plausible climate change scenarios for urban water governance in Lima. The first was led by a German-financed research program whose objective was to develop climate change scenarios and water simulation models (LiWA). The Metropolitan Municipality of Lima initiated the second process to develop city development strategies and a climate change adaptation strategy. The third process was an EU-financed programme - Chance2Sustain (C2S) - which opened a discussion on more spatial knowledge management perspectives in city development and water governance, linking knowledge construction and spatialising scenarios by mapping inequalities and areas of climate-related water vulnerabilities. This project made it possible to include community-based knowledge into such scenarios.

Although these processes used *concertación* and social knowledge construction, the actors and kinds of knowledge incorporated differed considerably. Whereas the first example remained largely dominated by professional groups and technical-professional knowledge, the city process and C2S processes included a broader range of actors and community knowledge and practices, resulting in a transition towards adaptive management and knowledge building.

However, no single actor has power over a city´s development. This holds true particularly in a metropolitan city such as Lima, where knowledge is dispersed and fragmented among several actors, and which lacks an overview about the present situation and, even more important, about the city´s future. Of course, actors do not necessarily have to know everything about every sector nor the whole city; the central issue in this research is how knowledge is constructed, shared/hidden and used, how knowledge travels and helps (or not) to build up mutual understandings among many actors, so they can not only communicate and coordinate but '*concertate',* to build up socially-supported agreements to take decisions and coherently act upon them.

The main conclusion from the discussion of the iterative mapping processes in *concertación* processes is that actors can build up agreements for collaborative action over time, with diverse water and development discourses as well as different territorial and city visions bringing in knowledge from different territorial scales and government levels. Such processes provide inputs for scenario building within cities towards future forms of water and climate change adaptations. However, such processes by necessity also include strong discussions, conflicts as well as recognition of the others' discourses and perspectives, that requires contextual-embedded knowledge to be included as well as expert-codified knowledge, to build up city scenarios capable of 'seeing' what might happen when conditions change in the future. As knowledge construction is connected to power relations between different actors and networks, those who acknowledge, contest or deny unequal water distribution or the results of scenario and risk mapping become much more visible, along with their reasoning, so issues become much clearer and easier to tackle.

This type of process does require contexts in which democratic and decentralised institutional frameworks exist. Providing strong mandates and political will can support such processes, so the views of the poor, vulnerable and excluded can be heard. Finally, there is greater recognition of other discourses in the Lima water governance configuration, which has recognised the approach to water as a human right (included as a constitutional right by the Peruvian Congress in 2018), and to some extent the socio-ecological approach (introducing a 1% extra charge to the water tariff for water sources protection). However, the dominant discourse of 'water as a commodity' still influences the institutions driving unequal water distribution which prevents water consumption and demand from being reduced and limiting the effectiveness eco-efficiency via market incentives alone.

8.4. Knowledge construction, decision-making and perceptions of water-related risks and vulnerability

In the fourth specific research question, I analysed how knowledge construction and risk perceptions of water-related disaster risks and vulnerabilities affect the decision-making and implementation in urban governance networks, specifically looking at some reasons behind high levels of risk tolerance and the lack of decision-making initiatives in putting more effective adaptation and/or preventive measures in place.

Three strands in the risks and vulnerability literature were found: the social construction of risks, governance and disaster risk management and climate change adaptation. First, the social construction of risk/disaster acknowledges that urbanisation ignores natural processes; it is not nature (the hydrological cycle) that is to blame for disasters, but rather how cities and infrastructure are built (Pfeffer, 2018). Second, disaster risk reduction incorporates the necessity to prevent several risk phenomena simultaneously and to include the relationships and synergies between them in risk and vulnerability evaluations, by analyzing past disasters and developing trends and projections out of them, and the decisive role taken by various levels of government and other actors in prevention, response and reconstruction strategies (Gupta et al., 2015; Pelling, 2011; Rosenzweig et al., 2018). The third is climate change adaptation and governance, which emphasises national and global agreements and perspectives. It is epitomised by the IPCC (2014c) concept, which presents a conceptual model of risk as the intersection between vulnerability, potential hazards and exposure to shocks and stresses, mediated by socioeconomic processes, climate, and large scale biophysical changes, involving scenarios with different levels of greenhouse gas emissions

and governance patterns. The multiple climate hazards under different emissions scenarios define the vulnerability that exacerbates and produces new risks, anticipating the potential of becoming disasters (Miranda Sara et al., 2015, interview Romero Lankao, 2014). Currently, such debates and discussions attempt to bring together the bodies of thought on disaster risk reduction and climate change adaptation, but they are still weak on their interrelations with the processes of the social construction of disasters.

The relation of perceptions of water-related risk to decision-making and the resulting adaptive and/or coping actions were analysed for this research question. New forms of metropolitan governance have constructed the spatial knowledge of water-related vulnerabilities, using inclusive and iterative scenario-building processes. These forms of governance unpack complexities, uncertainties and spatial inequalities in water governance, making them evident by mapping and spatial representations as strategic instruments for social and policy learning.

Two case studies were analysed for this, which may be or may become disasters (scenario-building). The first concerned the long-term plausible scenario of water scarcity and droughts resulting from the analysis of population growth rates, water distribution and consumption made during the Chance2Sustain research project and presenting spatial representations. The maps were used to define possible spatial interventions and were prioritised to deal with future water vulnerabilities in Lima. The second refers to the short-term extreme weather events that have already manifested themselves as mudslides, floods and El Niño in eastern Lima, Chosica. The first was investigated at the metropolitan city scale and the second at the scale of vulnerable communities. The cases illustrate both iterative knowledge of spatial construction, in which processes of risk prioritisation, normalisation and tolerance occurred and the resulting (in-) action of a variety of actors.

Using collective and iterative mapping processes with technical, organisational and geographical knowledge from a variety of governance actors, experts and practitioner networks in Lima, the research discovered that bringing together different knowledge and integrating several dimensions through spatial representations at multiple scales contributes to social learning. This raised awareness, increased capacities for dealing with uncertainty and contributed to the approved metropolitan climate change adaptation strategy and is actively updated by the new mayor of Lima Municipality since 2019.

There are two main conclusions: 1) territorial and spatial planning is a political process in which knowledge is contested, or even when acknowledged, it does not necessarily steer decision-making processes by local communities, authorities or private institutions; 2) existing models linking knowledge construction to risk framing, risk tolerance and how these influence decision-making processes and actions to prevent disaster may ignore the issues of risk tolerance, through normalisation and prioritisation, at their peril.

8.5. Knowledge building in configuring metropolitan water governance

In this section, I come back to the main research question, on how Lima´s water governance networks are being reconfigured in terms of discourses, actor network coalitions, territorialities of practice, and inclusionary knowledge-building processes to face water-related risks, vulnerabilities and climate change-related inequalities. The focus of this thesis was the changes that knowledge-building process in such configurations brings to ‘facing water-related risk, vulnerabilities and inequalities associated with climate change’. In doing

so, this thesis has brought together two broader debates: the first on 'configuring governance', the second on 'knowledge-building as social construction'.

In Lima, the concept of water governance configuration allowed us to examine how the water governance system is assembled via a powerful dominant network with the modernisation and privatisation discourses and agendas focused on the provision of urban drinking water. Its power allows it to maintain its discourse in the face of alternative conceptualisations emerging in regulatory and multi-scalar networks designed to increase equality in water provision, make allocation less competitive between various users in macro-regional and river-basin territories, increase climate change adaptation capacities and reduce risks related to climate change impacts at neighbourhood, metropolitan and macro-regional scales.

This concept brings out the importance of power relations in shaping discursive practices, as overlapping institutions, fragmentation of territorial mandates, regulatory powers, representation, participation and practices, and a lack of accessible, reliable and transparent policy knowledge, all prevent networks from developing a more integrated system. Using the concept has also made it possible to recognise the multi-scalar territorialities and water trajectories and show the lack of connections between the city, the macro-region and wider ecosystem levels. Within the metropolitan area, using the concept has also made visible the high levels of inequalities, vulnerabilities, and fragmentation of local communities, users and civic society groups when dominant and powerful discourse coalitions interact with weak networks, that lack the power to shift discursive practices towards changes urgently needed.

The way actors define their territoriality in practices influences their capacity to understand the 'whole' system at the macro-regional and multiple scale levels, as well as their capacity to understand how pieces of the water system fit into the overall water governance configuration with its fragmented and sectoral complexity. Three groups have been distinguished in relation to their spatial 'position' from where various actors observe the Lima water system and its dynamics:

a. From outside the city (from a macro or regional perspective or a territorial, river basin and/or rural and/or natural area perspective).
b. From inside the city (ward level and from there seeing the city as a whole with nearby rural zones).
c. From a multi-scalar perspective (global, macro, regional, territorial, basins, city, ward and vice versa) combining an urban, rural and natural understanding of water territories and hydrological cycle.

The water governance configuration as a conceptual framework has been developed by utilising several dimensions: discourses and mandates, actor coalitions and networks, power relations, territorialities of practices, decision-making processes and their outcomes (Baud et al., 2014; Sutherland et al., 2015). This conceptual framework on urban water governance has been linked to the debates on knowledge building, which provide insights into four main areas.

The first addresses the inequalities experienced in what knowledge is accepted and considered legitimate; ranging from knowledge forms, sourcing of knowledge, and the processes in which knowledge types are embedded (Pfeffer, 2018; van Ewijk et al., 2009). It links to the concept of governance configuration in the dimensions of discourses, and inclusionary (or not) processes of multi-actor decision-making (Miranda Sara et al., 2011).

The second insight concerns how spatialising, or mapping knowledge can contribute to making more visible inequalities, fragmentation and concentrations in 'territorialities' in practices. When such uneven geographies are combined with iterative-mapping process exercises in *concertación* processes, actors can build up common discourses on the situation concerned and agreements for collaborative action over time, bringing in knowledge from different territorial and governance levels. This provides better insights into how scenario-building processes within cities can be shaped toward future forms of water and adaptations to climate change.

However, the study also indicated that such processes by necessity include strong discussions and conflicts, as well as the recognition of the discourses and perspectives of others. They require the inclusion of contextual-embedded community knowledge and expert-codified knowledge, to build up city scenarios capable of 'seeing' and understanding what might happen when circumstances change. Politically, they require contexts in which democratic and decentralised institutional frameworks exist; local institutions provided with strong mandates and political will can support such processes, so the views of the poor, vulnerable and excluded can be heard.

The third insight concerns the ways that risk perceptions are linked to adaptive management and how different knowledges are embedded in such processes. Where they are not, or where they normalise risks, the possibility of disaster increases. A holistic approach to climate change adaptation, interlinked with risk reduction of disaster management and not only emergency responses, requires a change in 'knowing' the metropolitan city, generating a social construction of knowledge processes about those risks, involving a more integrative and relational approach, going beyond the sectoral (and fragmented) approach. This has proven a useful way to articulate how water-related climate risks are linked to urban development processes and metropolitan development processes and even contributing to mobilising national policies.

The fourth insight is that linking the issues of knowledge building to metropolitan water governance configuration contributes to a better understanding of the complexities faced by the actors in climate change and the uncertainties faced by those who want to tackle such issues.

We now turn to the implications for new research and future policy debates.

8.6. Implications for new research and policy

The main purpose was (and remains) to discover the ways and strategies which may drive new multilevel climate-proof metropolitan water governance configurations.

The way we incorporate the knowledge of vulnerabilities and risks and combine it with preventive measures is a highly political process. Both the IPCC and Sendai reports assume that linking knowledge and governance processes will be done, without suggesting possible uncertainty and conflict, which can prevent the acceptance of adaptation measures and the concomitant investments required for an uncertain future (IPCC, 2014b; UNISDR, 2015) [199].

[199] https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf (visited 25.06.2020)

However, existing situations of climate change denial, lack of preparedness to tackle disasters across multiple scales and institutional levels all indicate that even when there is better knowledge about risks and risk tolerance, a lack of transparency prevents governments, the private sector and communities from implementing stronger and urgent adaptive or preventive actions.

The series of consultations on scenario building, risk perception and expert analyses[200] helped to achieve agreements supporting the approval of the municipality's metropolitan strategy on climate change in 2014 and contributed to the action plan for water and sanitation in Lima and Callao by LiWA. The consultations contributed to open spaces for *concertación* without actors denying their own principles under the tensions of actor´s different discourses, knowledge, power imbalances and territorialities, which was the principal concern behind the main research question of this study. But these agreements were not properly implemented, either by the municipality or SEDAPAL. Scenario-building processes raised awareness, consensus and developed instruments, but they were acknowledged only after the disaster had struck.

The dominant actor network used their discourses, knowledge, political and/or economic power to avoid turning climate change scenarios into policy development before disasters, such as happened in 2017, affected them (see Foreword). The so-called 'Niño Costero' flooded the Rimac River, causing construction projects to collapse (quickened by shoddy construction and corruption in the building sector). Such flooding events happened all over the country and brought the unanimous approval of the climate change law in 2018 by the Congress of Peru. This new law gives formal mandates on climate change adaptation and mitigation measures to local governments, to assure the integration and transversality of the climatic component in public policies and investment projects. My knowledge built up through this research supported the formulation of the law when I became the environmental commission's key advisor responsible for writing the law. As said from the beginning, this research has been an active research process with a problem-solving focus, and it has reached such objectives, too.

The 2018 climate change law recognises that adaptation to climate change requires an integral, transversal, multi-sectoral, multi-actor and participatory management, as it establishes a new, favourable legal framework in which municipalities can rely on specific mandates in climate change to strengthen local governance networks. For instance, in 2018 and 2019 respectively, based on the Lima Climate Change Strategy already approved, 19 district municipalities (out of 52) of Lima and Callao have prepared the first version of their climate change adaption measures supported by the PRoaCC project (GIZ and Cities for Life Forum), applying a guide for the elaboration of adaption measures for climate change for metropolitan Lima municipalities[201]. The prioritised initiatives are being integrated into the respective municipalities' Institutional Operational Plans (POI) to allow them to be implemented in the future, and those municipal mayors are keen to make these investments without significant resistance so far.

The future outcomes are related to the current discourses and practices. However, goals for an equal metropolitan and sectoral water provision are often in contradiction with ecological

[200] Proyecto LiWA, www.lima-water.de (visited 12.06.2018)
[201] http://www.ciudad.org.pe/Items%20de%20portfolio/guia/ (visited 12.06.2019)

sustainability goals. They must therefore be reconsidered during the implementation processes involved. This study brought out the following contradictions:

- Universal provision (equal water for all) without reducing consumption implies extraction beyond ecological limits, where it may be impossible to replenish water flows in the hydrological cycle fast enough.
- Privatising water creates a conflict with more equitable distribution of water as a human right discourse and linking tariffs to the power to pay ensures that water is concentrated among larger, richer consumers, while inequalities in water tariffs remain (larger consumers pay less than smaller ones).
- Recognising water for the future leads to disputes over acceptable limits to water use and water scarcity and conflicts of distribution in maintaining water provision and urban ecosystems for the future.
- Water as a hazard means recognising disasters and vulnerability (drought, heavy rain, floods and '*huaycos*' related to climate risks) in keeping the city economically feasible and livable where high levels of vulnerabilities affect those who are poorer; this is the recognition of water as a sector (where actual infrastructure is not solving hazards) and as a socio-ecological good.

The conclusions have also been strengthened by some current policy shifts, such as the Conference of the Parties in 2015, the COP 20 held in Lima which provided more attention for improvements in climate change policies. Even the municipal administration changed politically in 2015. Before, it had removed the multi-actor climate change technical group, implementing only sluggish strategic measures at the cost of the most vulnerable. The actual municipal administration is promoting the elaboration of the metropolitan climate change action plan and has revived the technical group on climate change for that purpose.

The following are questions emerging for new research that need to be developed:

- How to build inclusive and interactive complex multi-actor, multi-scalar, multi-level and multi-temporal (short- to long- and very long-term) water governance structures for climate-proof metropolitan cities reconfigurations?
- How to lead, coordinate and integrate risk reduction, climate change adaptation and anticipate the process into uncertain and unknown city development futures?
- How to coordinate participation and inter-institutional spaces (between civil defence, river basin management and urban-rural-natural land use) with climate change scenarios?
- How can actor´s behaviours - public, private and communal - be modified to prevent and reduce risks, and to adapt city building through climate scenarios and opportunities to come?
- How can political will be built to ensure an equal supply of water over the long term?

8.7. Reflection on possibilities for reconfiguration?

There are opportunities for Lima's water governance reconfiguration, and this research showing where those opportunities are and what their limitations may be.

An entry point for interconnecting territories, water and cities with sustainability concerns and putting them at the top of the existing agenda needs more than a process of deliberation with discursive arguments of persuasion; even laws and regulations can be ignored or violated. The assumption behind this research was that once knowledge is socially constructed and shared

by multiple key actors from different actor networks, it may be followed by changes in decision-making. But this is a cycle which rarely happens immediately, taking time for a strong and lasting push to resolve the resistance to such a shift. Due to the long research period, I have been able to capture changes over time, with dominant actors using their power to resist climate change adaptation, losing influence when the disaster affected them and not just to the poor; this suggests that sudden shocks (disasters) produce greater and quicker transformations.

In the experience of Peru and particularly that of Lima, knowledge is more easily diffused in hybrid multi-actor and multi-institutional (and trans-disciplinary) networks, when the mandates and political policies (participatory and '*concertative*'[202]) are supported by transparent information as a pre-requisite. Such processes are iterative, and interactive cycles are in constant evolution and very dynamic, which may slowly contribute to reducing risk tolerance and overcoming the climate change adaptation resistance. However, to achieve a consistent reconfiguration of governance and decision-making for a climate-proof metropolitan city like Lima, Peru needs to overcome other challenges.

Politics in Peru are unpredictable and unstable. As Peru has seen[203] the workings of secrecy, concealment, opacity and the weakness (and hiding) of information, it favours growing processes of corruption. Corruption also makes processes of establishing and implementing agreements more difficult and prevents the co-creation of transformation processes. Since 2018, Peru and Lima have been embroiled in corruption scandals (Durand, 2019; Vergara, 2018) and as shown in the news and newspapers regarding the Lava Jato scandal in Perú, particularly concerning city construction and water infrastructure[204]. This is a real barrier to reconfiguring water governance networks and to build mechanisms for shifting and rebalancing power relations between multiple actors and networks.

In 2019, the water governance configuration started changing in Lima. The dominant network is weakening, with the regulators and control network bringing back justice with a new generation of judges and public prosecutors, backed by police and journals investigating corruption, along with public support. Emerging networks on inter-river basin water governance, the 'decentralisation wing' network, which were weaker, are getting stronger. The president of Peru, a former regional governor, is seeking to increase the budgets of regional and local government and calls for more decentralisation.

As stated, climate change and city concerns are also back in the discussion. The mayor of Lima is supporting the development of the Climate Change Action Plan and updating the strategy and the urban development plan included in the vision that 'Lima is prepared for climate change effects'. Ultimately, the municipality of Lima proposes to establish a geographic information system for metropolitan Lima and to bring back discussions of metropolitan policy with territorial and urban perspectives and their long-term concerns.

[202] A variety of actors take part, even in processes with an obligatory character, in which one learn by doing, one constructs a collective knowledge through diverse discussions, spaces of dialogue and even through social networks.
[203] After Lava Jato scandals
[204] Sadly, explaining the malfunction of the Potable Plant of Huachipa (producing only 1 m3 instead of 5 meant to cover those unconnected families) and the collapse of the Sewerage Main collectors of San Juan de Lurigancho east of Lima in 2018 (flooding with waste water more than 200 families in a poor area east Lima)

Personal reflections

A research project like this, in which you study the *concertación* processes that you facilitate or initiate, affects both your professional and your personal life.

At the end of 2017, I became an IPCC member (I was formally invited by Peruvian Ministry of Foreign Affairs), and this position allows me to have a greater impact and more influence on cities, water and climate change issues than I have ever experienced, not only in Lima but also in the country (and globally). Since 2019, Foro has also become the National Coordinator of the Global Covenant of Mayors in Peru with the InterUrban Programme (sponsored by EU), and we are promoting the development of 24 municipal climate change action plans among 12 Peruvian cities. This research has therefore helped both the Foro and myself to strengthen our position in guiding policy development processes.

I cannot finish this text without recognising that I have faced three main difficulties or constraints. The first one is that you cannot *concertate* without the achievement of a common understanding and shared knowledge being built among actors who need to manage the same level of information. However, as I have argued earlier, knowledge tends to remain where it has been generated (Hordijk et al., 2006). Knowledge sharing is still weak, with water-related, territorial and climate change knowledge still fragmented, dispersed and/or ignored both in Lima and even in Peru. The actors and institutions involved in water-related activities in Peru are very diverse, fragmented and in competition. They work with limited information and make little effort to share information. Particularly the lack of good quality GIS spatial knowledge within the institutions has demanded an enormous amount of work just to clarify the information coming from different scales and from overlapping and fragmented institutional levels increasing the complexity of 'knowing' the water flows around metropolitan Lima.

The second main constraint of my research process, and probably the most important one, was the high level of corruption in the political environment in the country and Lima. It was a real barrier; corruption has become normalised and accepted and posing makes it almost impossible to negotiate equally. The practice was those dominant actors negotiated and brought power-play dynamics into the processes to establish a dominant discourse and actors and networks, rather than building up agreements. It is quite a challenge to develop *concertacion* processes under the threat of corruption and with corrupted actors.

The third one was time, the level of time consumption of such a process is high and goes far beyond a traditional PhD research process. Without the support of FORO, the already mentioned research projects and the Municipality of Lima (during 2013/2014 and recently the current administration) and the patience of my daughter having to deal with my prolonged absences, the main results of this research would not have been reached.

Only the mobilisation of the (at last) *informed* Peruvian citizens, after the dissemination of tapes evidencing the level of corruption and even the direct confession of corrupted key actors (of former presidents, ministers, supreme court judges, prosecutors, political party leaders, and private corporations) by responsible journalists is generating an expectation of changes not seen in decades in the country and in Lima. The Peruvian experience demonstrates that information and knowledge sharing can mobilise change.

Appendix

About the author

Originally I was an architect, nowadays an urban environmental expert, planner, researcher, and activist. I have several post grades and a master's in real estate and construction management. I am IPCC 6th Assessment Report lead author, chapter 12th. I developed my PhD studies at Amsterdam University, GPIO Department, GID programme within a "sandwich system". I am an invited Masters programme teacher at several Universities in Peru and abroad. Founder and Executive Director of Cities for Life Foro inter-institutional network (municipalities, universities, and civil society from 18 cities) in Peru and Coordinator - together with National Association of Municipalities of Peru, AMPE - of the Peru work of the Global Covenant of Mayors for Climate and Energy. I am also a consultant of national and international organizations and former Principal Advisor of the Environmental Commission and Indigenous Communities in the Congress of Peru.

I have published 5 books, 15 peer review (mainly English) articles, 12 book chapters. I write a monthly article at a governmental journal in Peru since 2014 and being a civil society activist, I use mass media, journals, and social networks regularly. I am engaged in world-wide conferences, such as the Conference of the Parties (UNFCC), UNCSD - Rio + 20, and World Urban Forum and Habitat. I am an Ashoka fellow and Avina Leader with several other recognitions for my trajectory and policy development impact.

I develop private consultancy, working on issues such as Local Climate Action Plans, Consensus Building, Capacity Building, and Political Incidence Campaigns in Sustainable Construction for the poor (involving green infrastructure and landscape), Territorial Sustainable Planning and Sustainable Development such as Cities Agenda 21. Thanks to my work I have visited almost the whole world´s largest cities in most continents.

Journals and book chapter´s publications

Publications linked to this thesis, contributions of each author to published articles is indicated

Miranda Sara, L., Pfeffer, K., Baud, I.S.A. (2017). Unfolding Urban Geographies of Water-Related Vulnerability and Inequalities, Recognising Risks in Knowledge Building in Lima, Peru. Book chapter in: Bell, S., Allen, A., Hofmann, P., Teh, T.(eds.) (2017). Urban Water Trajectories. Pp. 81-98. Springer Verlag.

The first author was the primary author of the chapter, which she planned, collected the data within scenario workshops in two larger research projects (LIWA and Chance2Sustain), and analysed the results. The second author was a member of the research network Chance2Sustain and contributed to the scenario workshops, prepared the maps analysing the data visualisation shown in the chapter and contributed to the joint discussions with the first and third author. The third author contributed to discussions, and critically edited the chapter in preparation for publication.

Miranda Sara, L., Baud, I.S.A. (2014) Knowledge-building in adaptation management: concertación processes in transforming Lima water and climate change governance, in Environment and Urbanization. 26:2, 505-524.

The first author set out the issues, collected the data, and analysed it. Her work in Chance2Sustain provided a strong background for the discourse analysis. The second author contributed through critical discussions of the material and writing up in article format.

Miranda Sara, L., Jameson, S., Pfeffer, K., Baud, I.S.A. (2016), Risk Perception: the social construction of knowledge around climate change-related scenarios in Lima, Habitat International. 53: 1-14.

The first author set out the issues, collected the data, and analysed it. The second and third authors were sparring partners linking results to the academic debates and supporting the writing up. The final author critically supervised and supported the writing up and editing of the chapter.

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